



Updates on Modeling Efforts of Nueces BBASC Technical Consultant

Presentation to Nueces BBASC

Sam Vaughn, PE

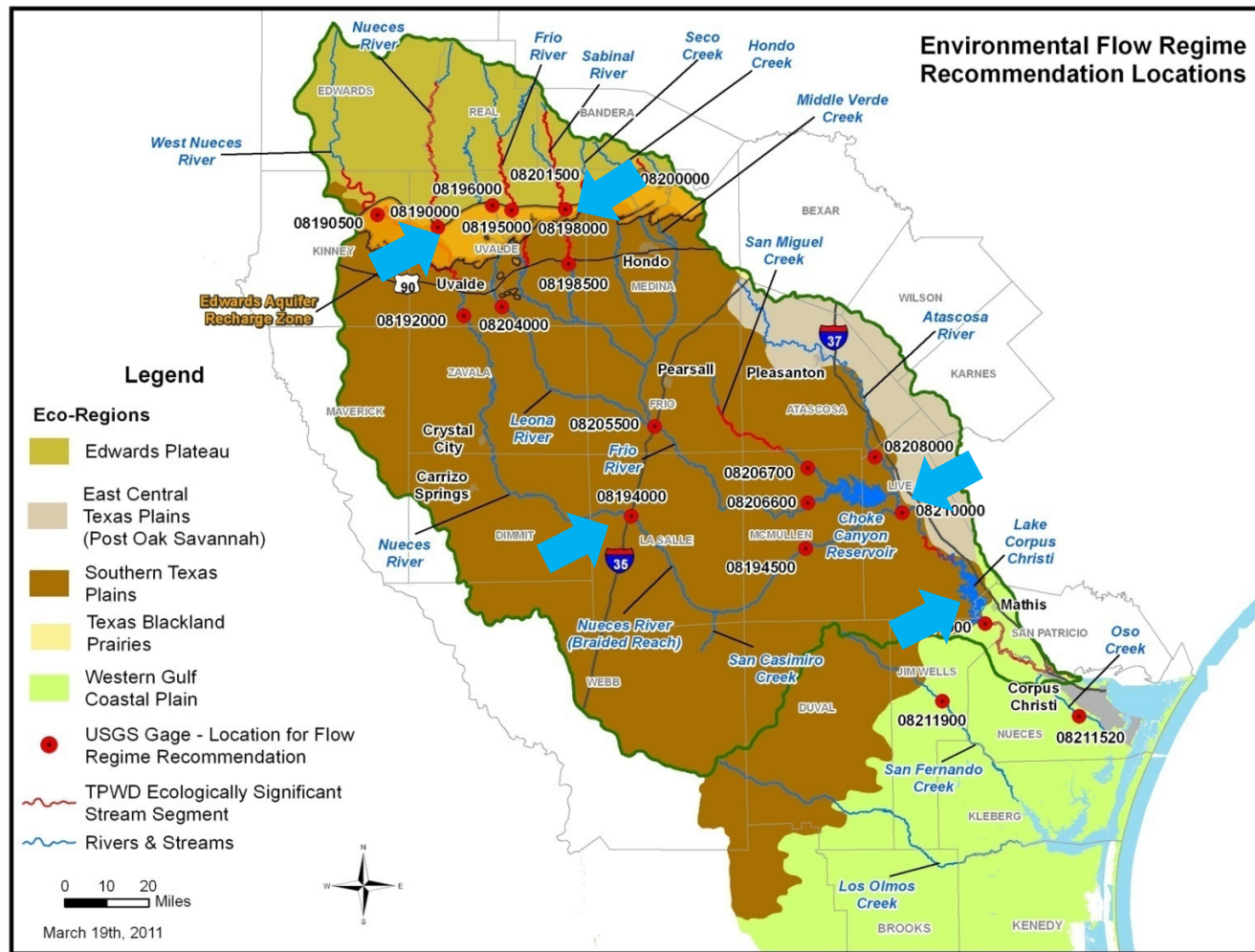
Cory Shockley, PE – HDR Engineering

April 25, 2012

Discussion

- Instream Flow
 - Planned Water Supply Project Evaluations
 - Sabinal Recharge Dam
 - Standard and Strategy Evaluation
 - Nueces River @ Laguna
 - Nueces River @ Cotulla
- Nueces Bay & Delta
 - Planned Water Supply Project Evaluations
 - Lake Corpus Christi Off Channel Reservoir
 - B&E Scenario Evaluation

Focal Sites for BBASC Instream Flow Standard Recommendations

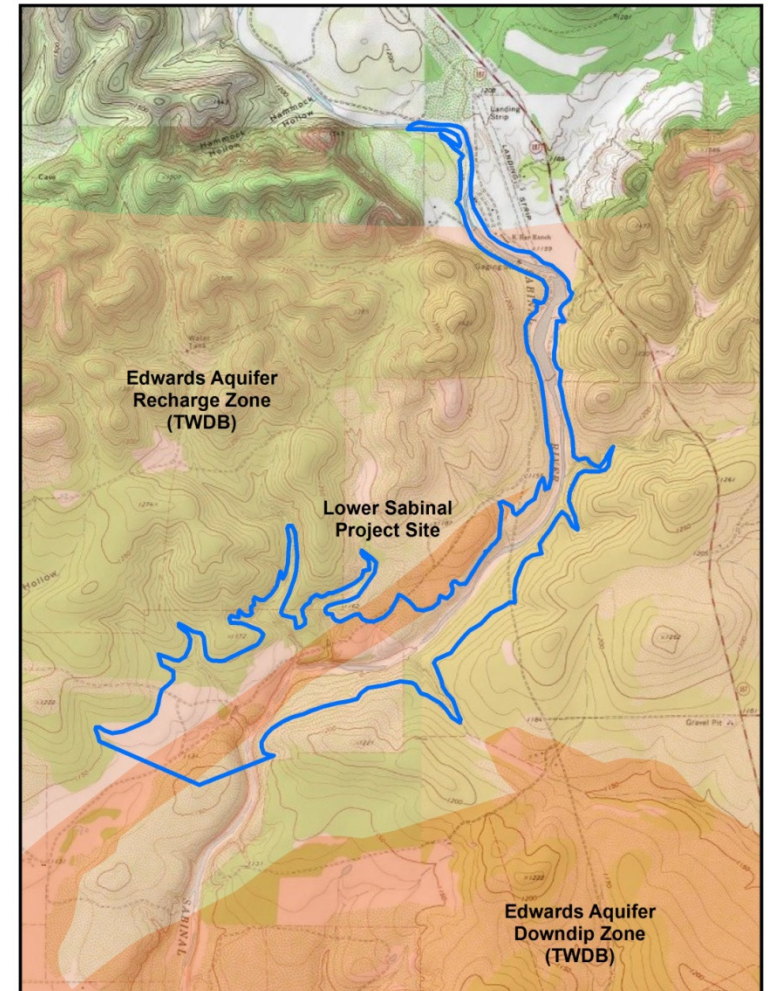


Planned Water Supply Projects

- Lower Sabinal Recharge Project
- Potential Environmental Flow Standards
 - No E-Flow Restrictions
 - Lyons (TCEQ)
 - CCEFN (Regional Water Planning)
 - Full BBEST

Lower Sabinal Recharge Project

- Recommended - Region L Plan
- Capacity 8,750 acft
- Enhanced Recharge
 - The additional recharge that would occur across the entire Edwards aquifer recharge zone on the Sabinal River from the implementation of the Sabinal Recharge Dam.



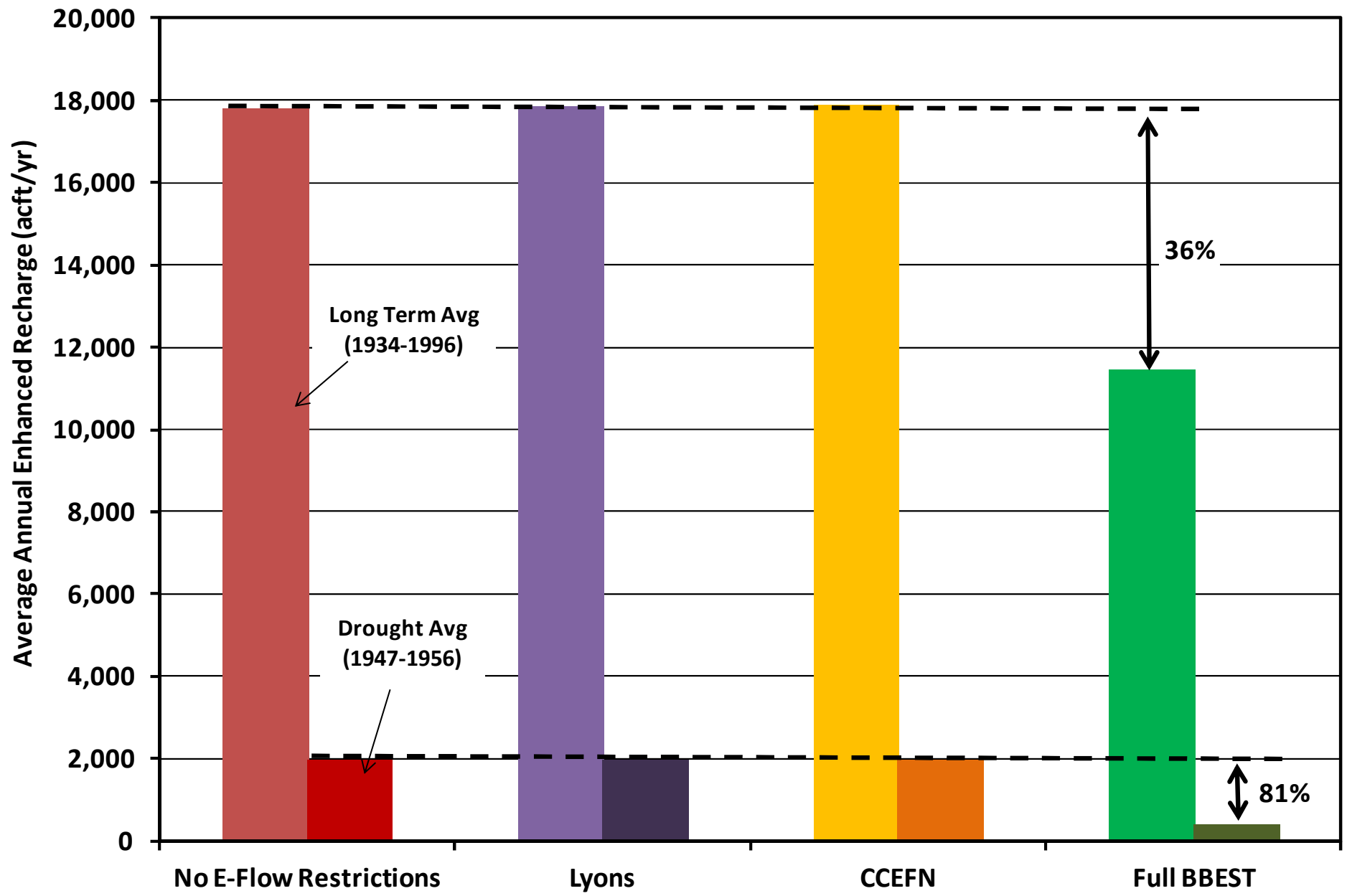
Sabinal River near Sabinal

High Flow Pulses	Qp: 5,200 cfs with Average Frequency 1 per 5 years Regressed Volume is 46,200 Duration Bound is 75											
	Qp: 2,350 cfs with Average Frequency 1 per 2 years Regressed Volume is 20,000 Duration Bound is 54											
	Qp: 1,020 cfs with Average Frequency 1 per year Regressed Volume is 8,290 Duration Bound is 36											
	Qp: 330 cfs with Average Frequency 2 per year Volume Bound is 5,420 Duration Bound is 24											
	Qp: 62 cfs with Average Frequency 1 per season Volume Bound is 1,530 Duration Bound is 17			Qp: 180 cfs with Average Frequency 1 per season Volume Bound is 2,210 Duration Bound is 15			Qp: 100 cfs with Average Frequency 1 per season Volume Bound is 1,180 Duration Bound is 12			Qp: 53 cfs with Average Frequency 1 per season Volume Bound is 840 Duration Bound is 11		
				Qp: 64 cfs with Average Frequency 2 per season Volume Bound is 750 Duration Bound is 10			Qp: 11 cfs with Average Frequency 2 per season Volume Bound is 130 Duration Bound is 5					
				Qp: 22 cfs with Average Frequency 3 per season Volume Bound is 240 Duration Bound is 6								
Base Flows (cfs)	35						29			35		
	21						13			21		
	11			8			3			10		
Subsistence Flows (cfs)	1											
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Winter				Spring			Summer			Fall	

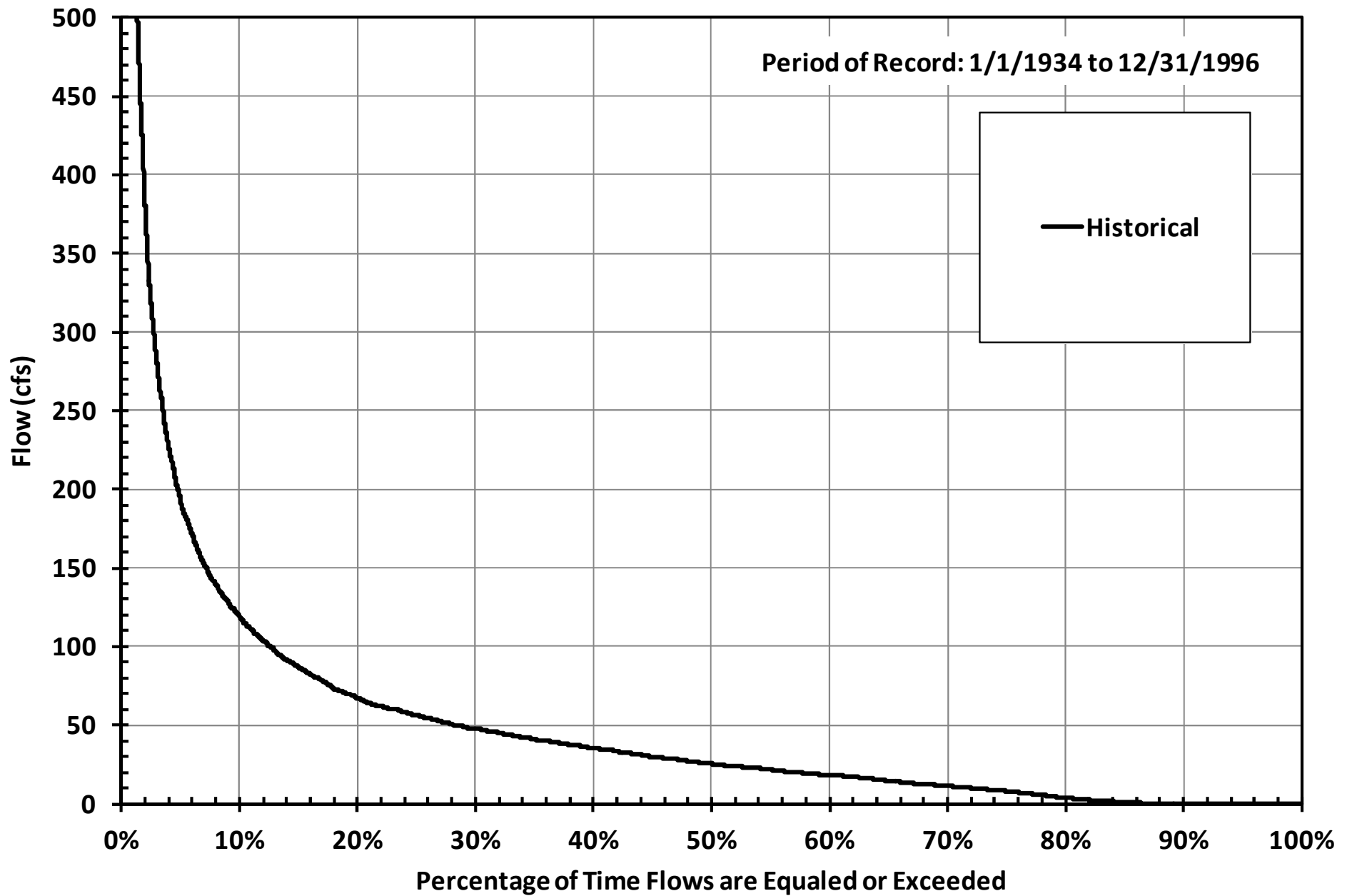
Flow Levels	High (75th %ile)
	Medium (50th %ile)
	Low (25th %ile)
	Subsistence

Pulse volumes are in units of acre-feet and durations are in days.
Period of Record used: 1/1/1943 to 12/31/2009.

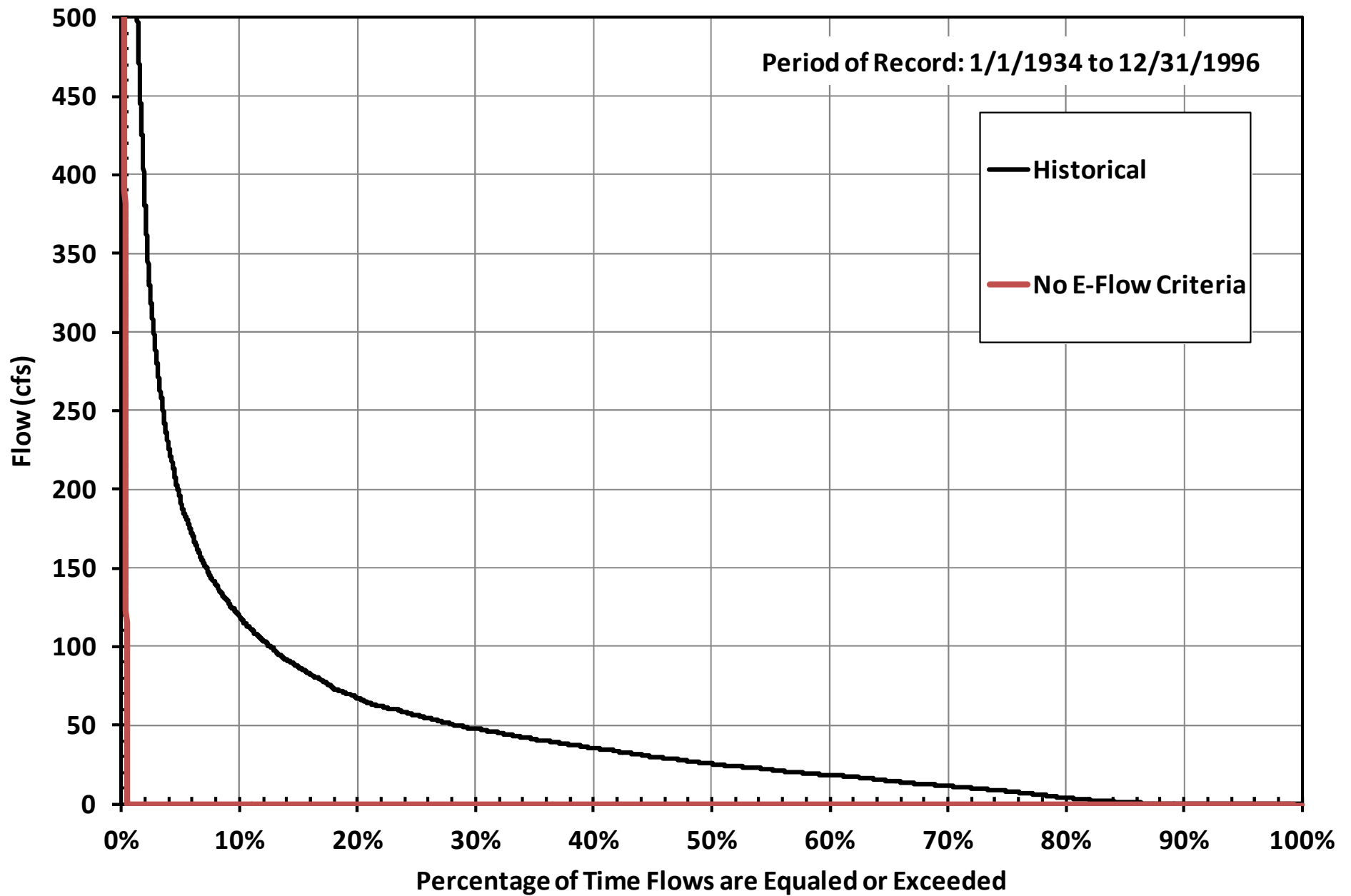
Sabinal River at Sabinal Recharge Reservoir - Enhanced Recharge



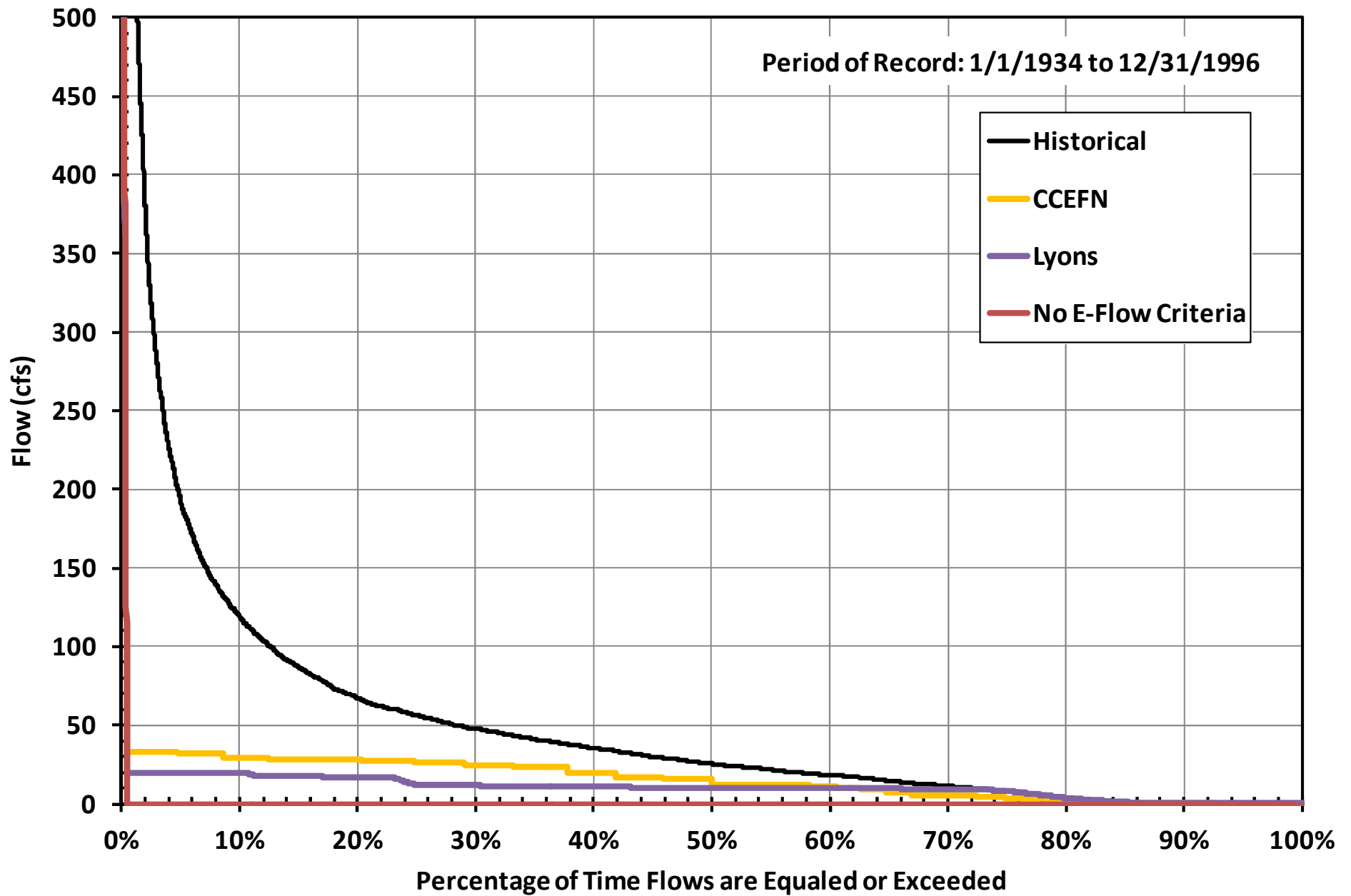
Sabinal River at Sabinal Recharge Reservoir - Annual Flow Frequency Curve



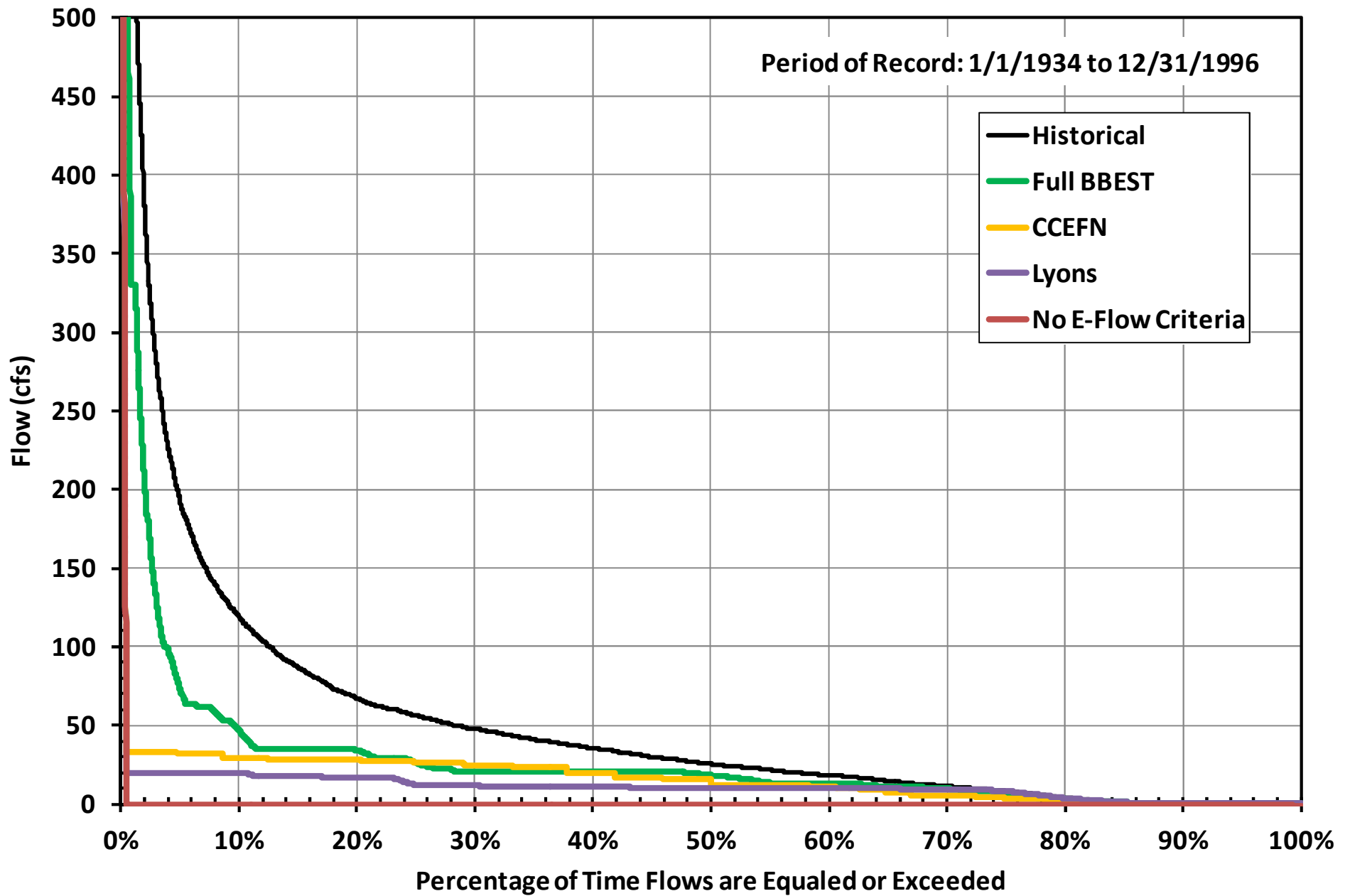
Sabinal River at Sabinal Recharge Reservoir - Annual Flow Frequency Curve



Sabinal River at Sabinal Recharge Reservoir - Annual Flow Frequency Curve



Sabinal River at Sabinal Recharge Reservoir - Annual Flow Frequency Curve





Sabinal Recharge Dam

- Preliminary Conclusions
 - The impoundment of high flow pulses by the Sabinal Dam provides the greatest opportunity for recharge enhancement.
 - Variations in base flow criteria have negligible effects on enhanced recharge.
- Downstream Impacts
 - System yield = -1,900 to -2,300 acft/yr
 - Average Annual Bay Inflow = -850 acft/yr

Standard & Strategy Evaluation

- Laguna ROTR with OCR
- Cotulla Reservoir
- Cotulla ROTR with OCR
- Evaluate:
 - No Recommendation
 - BBEST Recommendation
 - Modifications to BBEST Recommendation
- Results:
 - Yield
 - Streamflows

Laguna ROTR - OCR

- Environmental Flow Standards
 - None
 - Full BBEST
 - Modified BBEST
 - No Overbank Flow Criteria
 - No Overbank with Pulse Exemption
 - No Overbank with Pulse Exemption and Dry Base Flows
 - No Overbank with Pulse Exemption and 50% Rule with Avg. Base Flows

E-Flow Criteria Definitions

- Overbank Exemption
- Pulse Exemption Rule
 - If the diversion rate of a run-of-river or off-channel reservoir diversion is less than 20% of the flow pulse trigger, then the pulse can be omitted from the E-flow criteria.
 - The 20% rule is not applicable to on-channel reservoirs
- Single Tier of Base Flows
- Single Tier of Base Flows with 50% Rule
 - Diversions may not exceed 50% of the difference between the base flow and the subsistence flow.

Nueces River @ Laguna - BBEST

Overbank Events	Qp: 600 cfs with Average Frequency 1 per 5 years Duration Bound is 107											
High Flow Pulses	Qp: 4,750 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,600											
	Qp: 590 cfs with Average Frequency 2 per year Volume Bound is 11,300 Duration Bound is 46											
	Qp: 48 cfs with Average Frequency 1 per season Volume Bound is 1,000 Duration Bound is 7			Qp: 390 cfs with Average Frequency 1 per season Volume Bound is 6,070 Duration Bound is 17			Qp: 170 cfs with Average Frequency 1 per season Volume Bound is 3,100 Duration Bound is 14			Qp: 50 cfs with Average Frequency 1 per season Volume Bound is 800 Duration Bound is 5		
				Qp: 99 cfs with Average Frequency 2 per season Volume Bound is 1,560 Duration Bound is 9								
Base Flows (cfs)	92			76			92			92		
	85			48			65			65		
	51			44			32			41		
Subsistence Flows (cfs)	14			18			16			14		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Winter				Spring			Summer			Fall	

Flow Levels

High (75th %ile)
Medium (50th %ile)
Low (25th %ile)
Subsistence

Pulse volumes are in units of acre-feet and durations are in days.
Period of Record used : 1/1/1924 to 12/31/2009.

Nueces River @ Laguna - BBEST

Overbank Events	Qp: 600 cfs with Average Frequency 1 per 5 years Duration Bound is 107											
High Flow Pulses	Qp: 4,750 cfs with Average Frequency 1 per 2 years Regressed Volume is 38,600											
	Regressed Volume is 18,400 Duration Bound is 46											
	Qp: 590 cfs with Average Frequency 2 per year Volume Bound is 11,300 Duration Bound is 26											
	Qp: 48 cfs with Average Frequency 1 per season Volume Bound is 1,000 Duration Bound is 7			Qp: 390 cfs with Average Frequency 1 per season Volume Bound is 6,070 Duration Bound is 17			Qp: 170 cfs with Average Frequency 1 per season Volume Bound is 3,100 Duration Bound is 14			Qp: 50 cfs with Average Frequency 1 per season Volume Bound is 800 Duration Bound is 5		
				Qp: 99 cfs with Average Frequency 2 per season Volume Bound is 1,560 Duration Bound is 9								
Base Flows (cfs)	92			76			92					
	65			48			65					
	31			44			32			41		
Subsistence Flows (cfs)	14			18			16			14		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Winter				Spring			Summer			Fall	

Flow Levels

High (75th %ile)
Medium (50th %ile)
Low (25th %ile)
Subsistence

Pulse volumes are in units of acre-feet
Period of Record used : 1/1/1924 to 1

50%

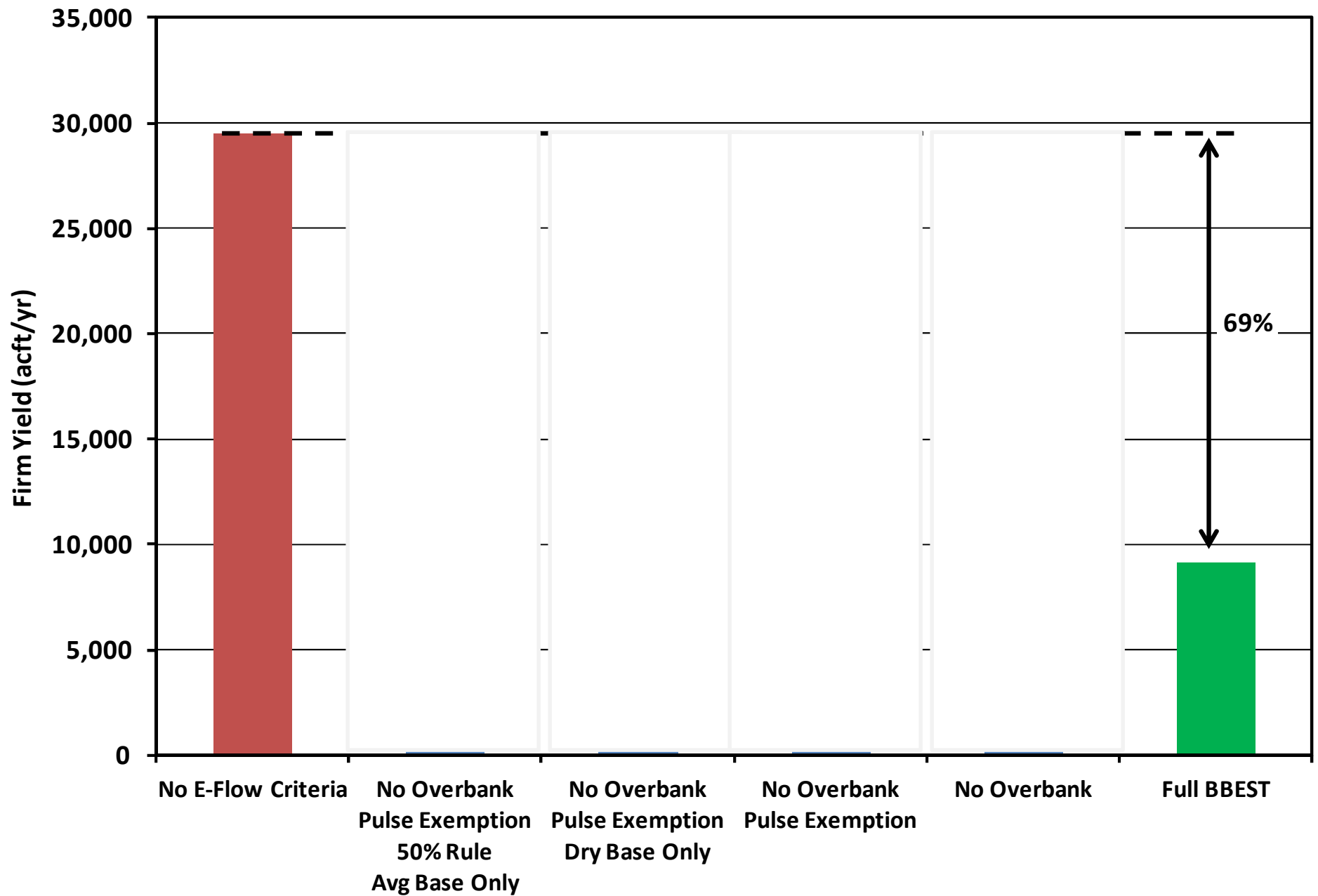
Nueces River @ Laguna

Hypothetical Project

- Run of the River Diversion (400 cfs)
- Off Channel Reservoir (44,000 acft)



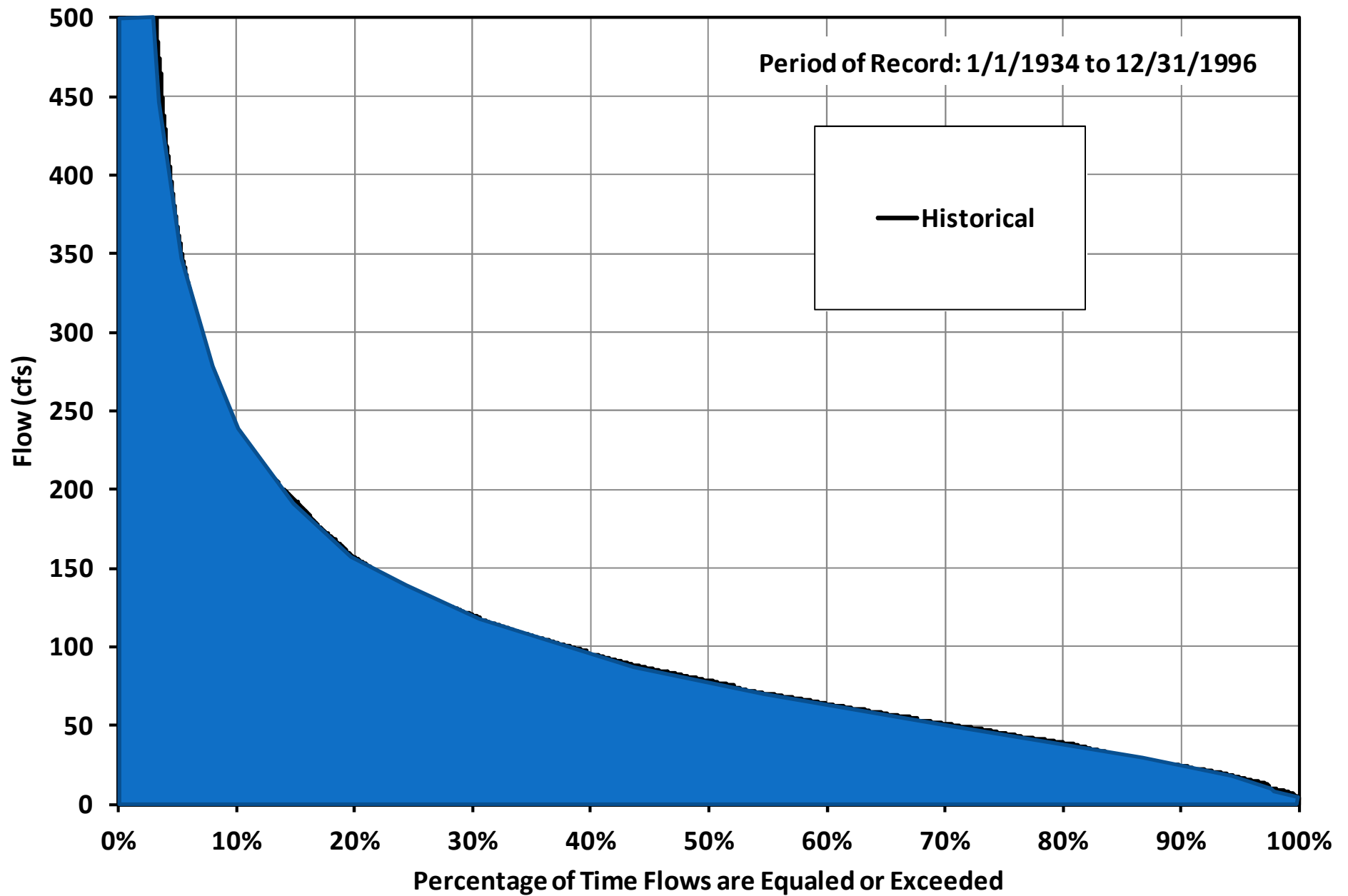
Nueces River at Laguna OCR - Firm Yield



Defined – Modified BBEST

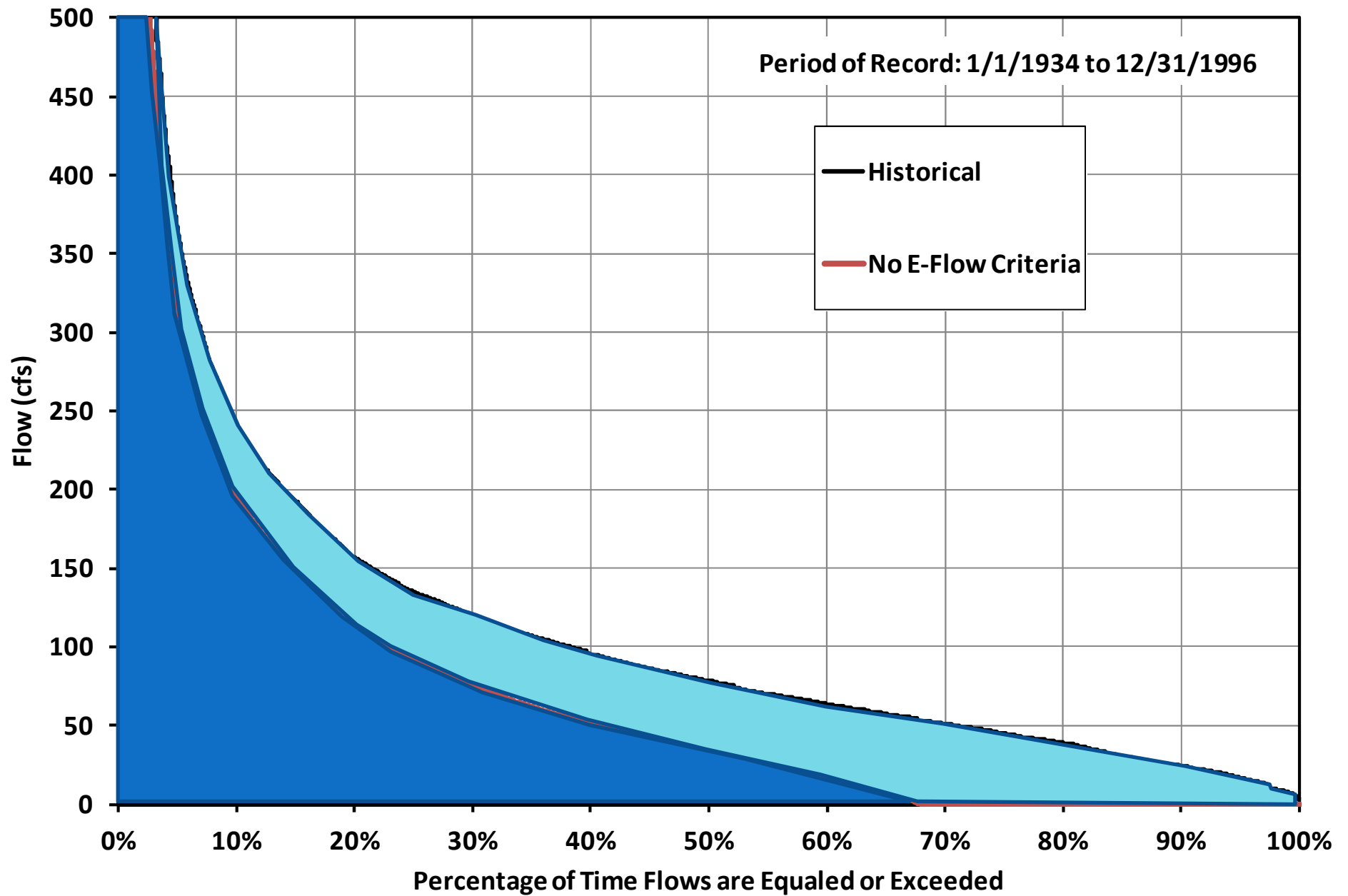
- Overbank Exemption
- Pulse Exemption Rule
 - diversion rate < 20% of the flow pulse trigger
 - 20% rule not applicable to on-channel reservoirs
- Single Tier of Base Flows with 50% Rule
 - Diversions may not exceed 50% of the difference between the base flow and the subsistence flow.

Nueces River at Laguna OCR - Annual Flow Frequency Curve



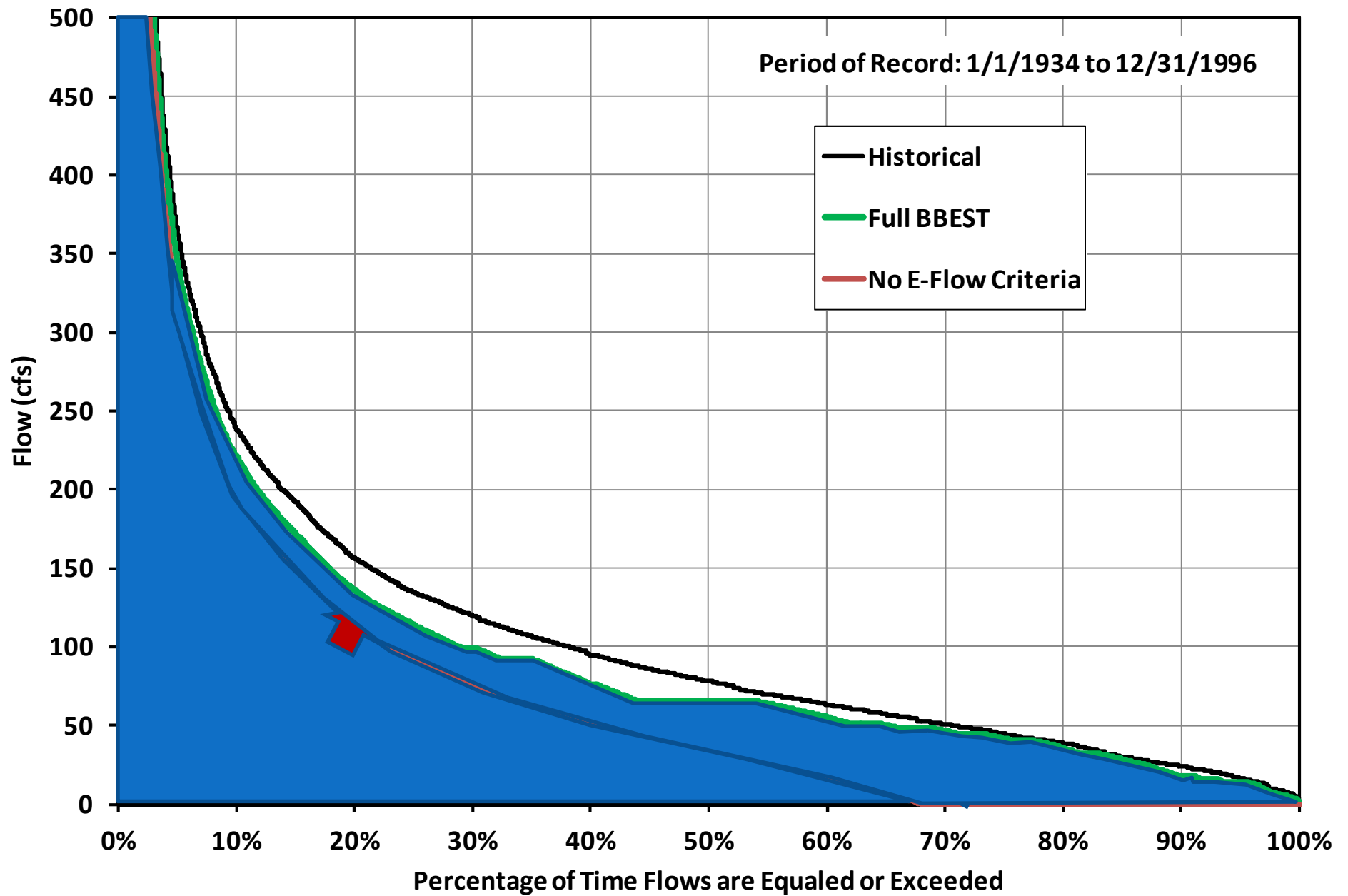
Nueces River at Laguna OCR - Annual Flow Frequency Curve

Period of Record: 1/1/1934 to 12/31/1996

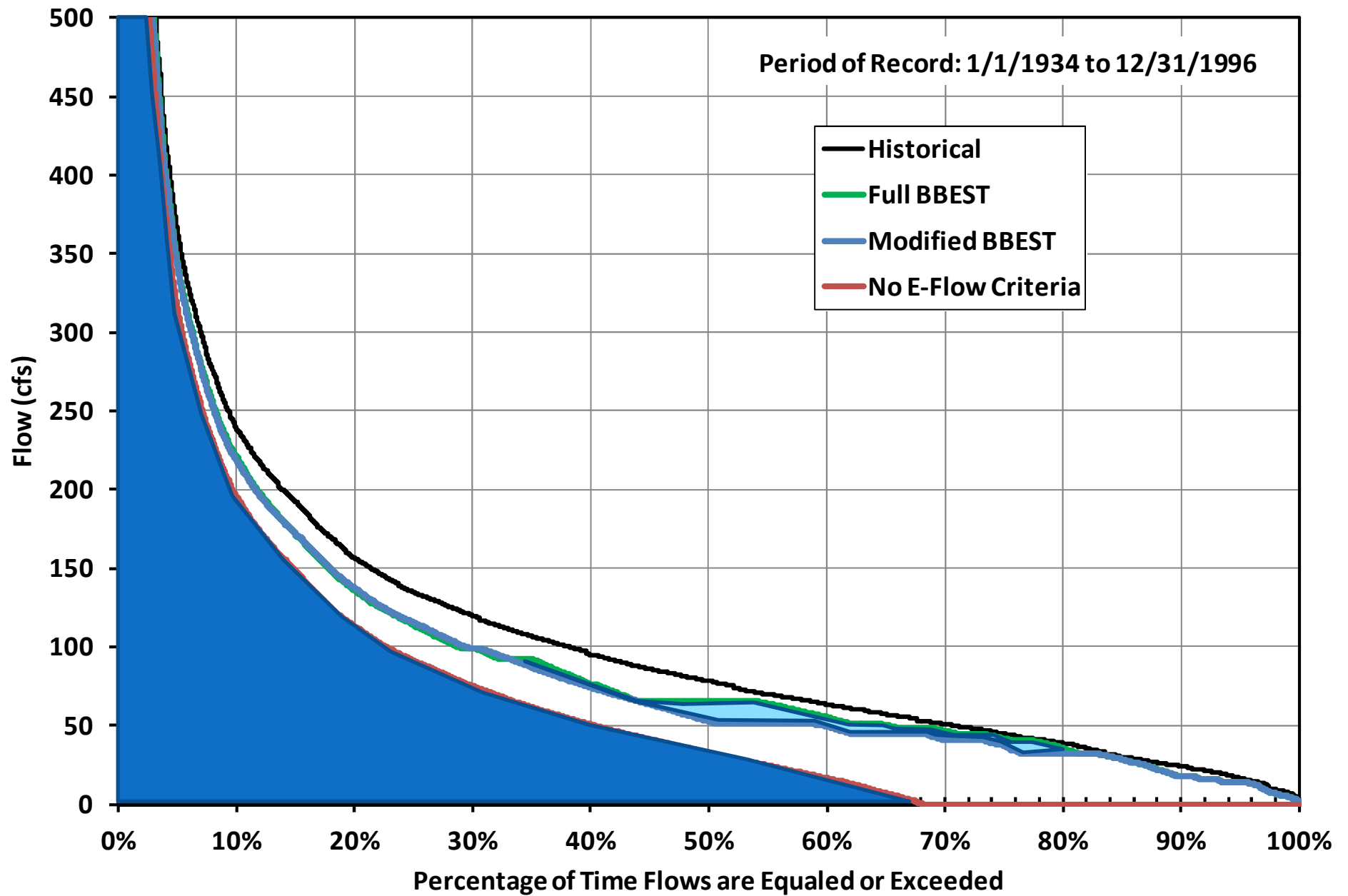


Nueces River at Laguna OCR - Annual Flow Frequency Curve

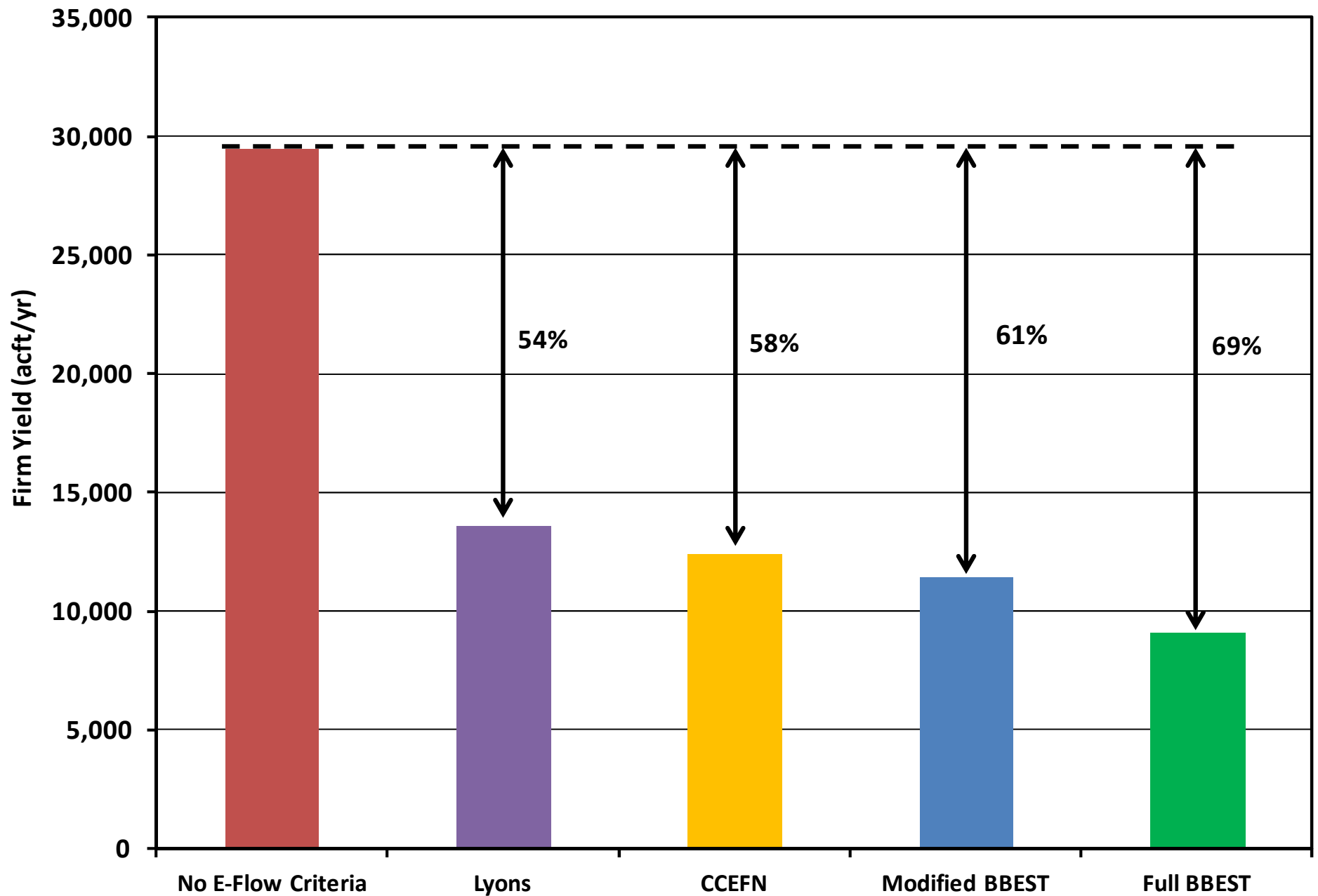
Period of Record: 1/1/1934 to 12/31/1996



Nueces River at Laguna OCR - Annual Flow Frequency Curve

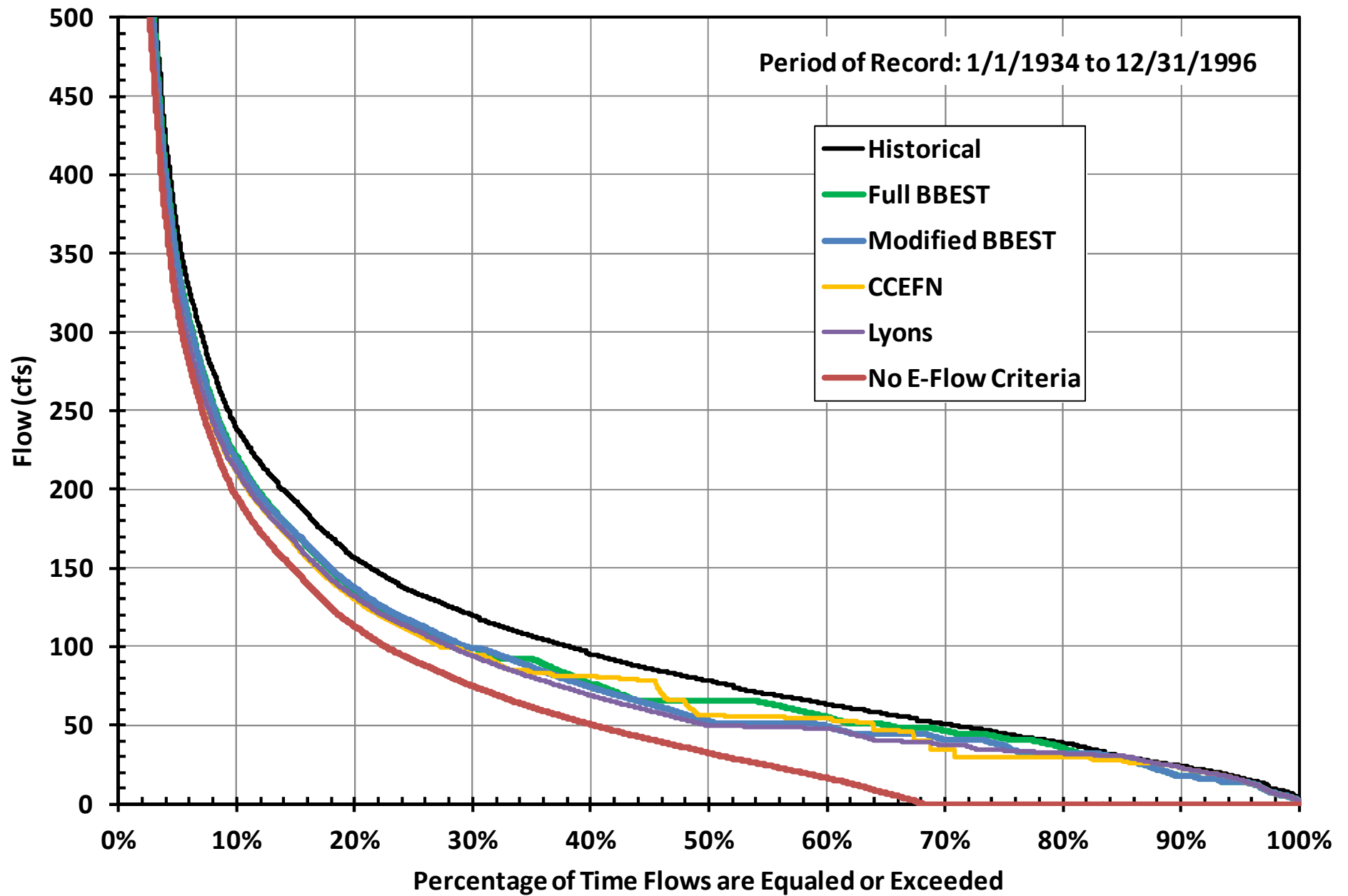


Nueces River at Laguna OCR - Firm Yield



Nueces River at Laguna OCR - Annual Flow Frequency Curve

Period of Record: 1/1/1934 to 12/31/1996



Nueces River @ Cotulla

Hypothetical Projects

- Cotulla Reservoir – On Channel
 - Capacity = 527,000 acft
- Cotulla ROTR – Off Channel
 - Diversion = 400 cfs
 - Capacity = 40,000 acft



Nueces River @ Cotulla - BBEST

Overbank Events	Qp: 15,100 cfs with Average Frequency 1 per 5 years Regressed Volume is 151,000 Duration Bound is 42											
	Qp: 8,410 cfs with Average Frequency 1 per 2 years Regressed Volume is 80,700 Duration Bound is 38											
	Qp: 4,460 cfs with Average Frequency 1 per year Regressed Volume is 41,100 Duration Bound is 34											
	Qp: 1,560 cfs with Average Frequency 2 per year Volume Bound is 24,200 Duration Bound is 28											
High Flow Pulses	Qp: 96 cfs with Average Frequency 1 per season Volume Bound is 1,570 Duration Bound is 20				Qp: 1,180 cfs with Average Frequency 1 per season Volume Bound is 17,200 Duration Bound is 24				Qp: 100 cfs with Average Frequency 1 per season Volume Bound is 1,030 Duration Bound is 16		Qp: 640 cfs with Average Frequency 1 per season Volume Bound is 8,610 Duration Bound is 26	
	Qp: 8 cfs with Average Frequency 2 per season Volume Bound is 100 Duration Bound is 13				Qp: 190 cfs with Average Frequency 2 per season Volume Bound is 2,370 Duration Bound is 17						Qp: 35 cfs with Average Frequency 2 per season Volume Bound is 360 Duration Bound is 14	
					Qp: 15 cfs with Average Frequency 3 per season Volume Bound is 150 Duration Bound is 11							
Base Flows (cfs)	38				31				42			
	6				10				7		15	
Subsistence Flows (cfs)	1											
	1											
<div>Nov</div> <div>Dec</div> <div>Jan</div> <div>Feb</div> <div>Mar</div> <div>Apr</div> <div>May</div> <div>Jun</div> <div>Jul</div> <div>Aug</div> <div>Sep</div> <div>Oct</div>												
<div>Winter</div> <div>Spring</div> <div>Summer</div> <div>Fall</div>												
Flow Levels			Pulse volumes are in units of acre-feet and durations are in days. Period of Record used : 1/1/1927 to 12/31/2009.									
			High (75th %ile)									
			Medium (50th %ile)									
			Low (25th %ile)									
			Subsistence									

28

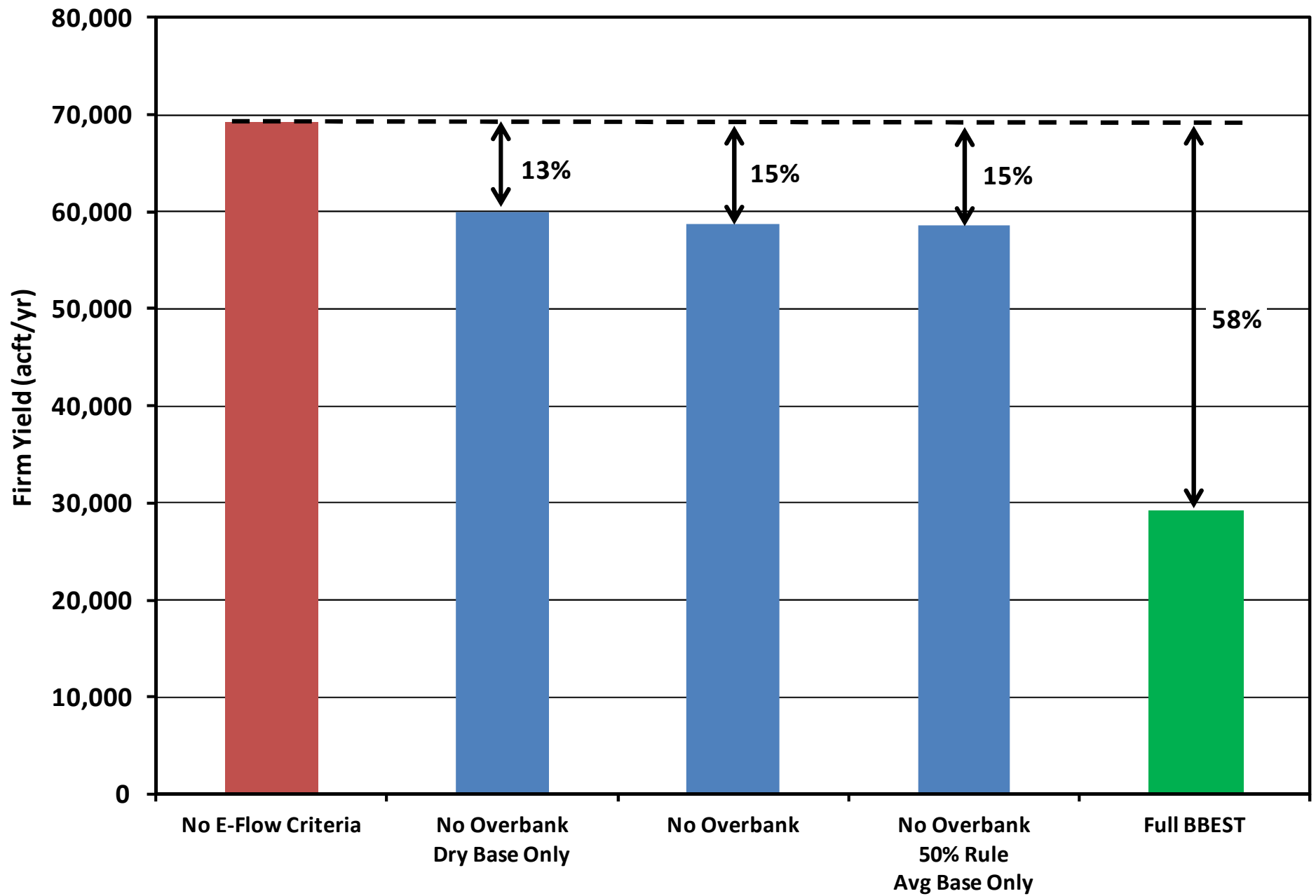
Pulse volumes are in units of acre-feet and durations are in days.
Period of Record used : 1/1/1927 to 12/31/2009.



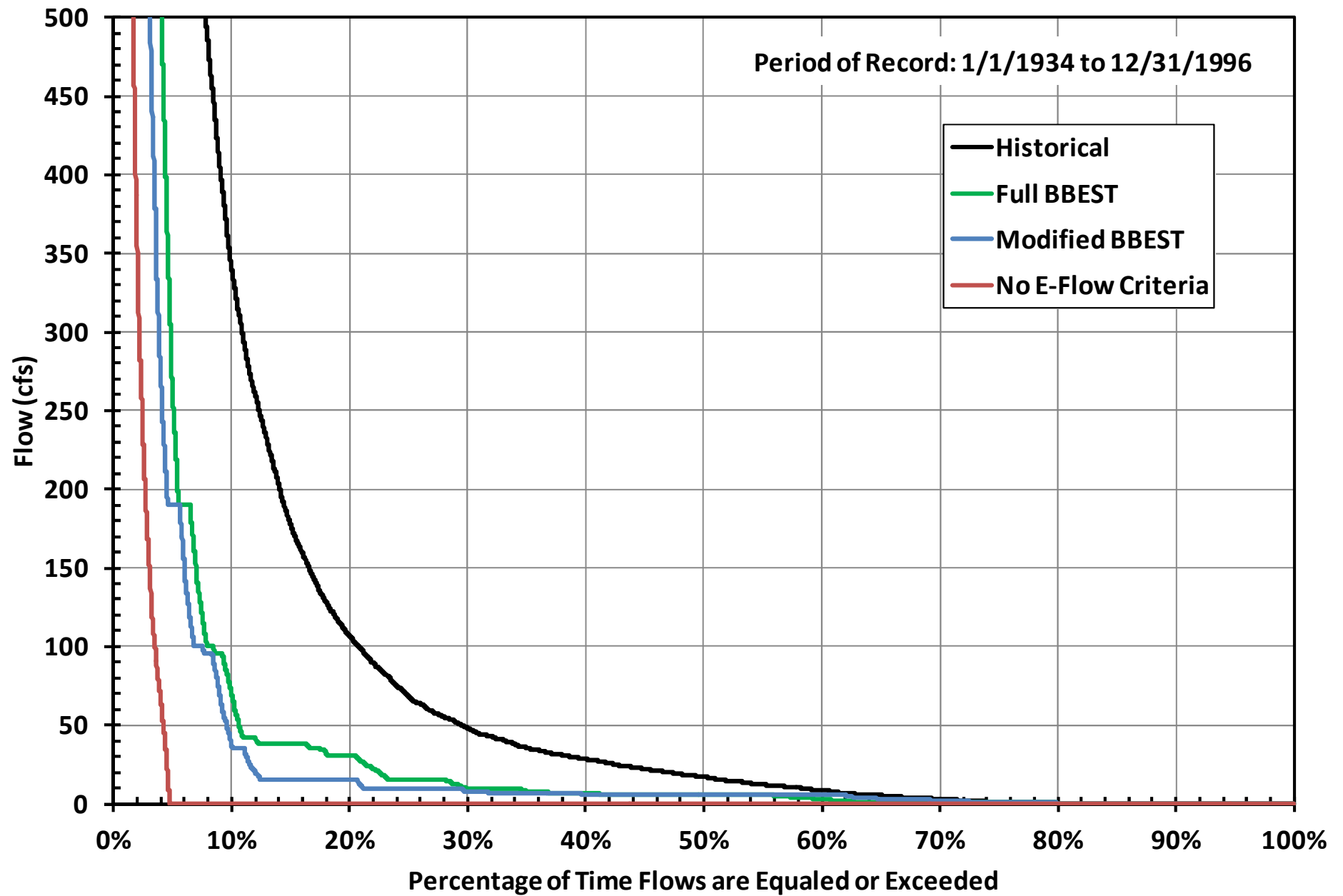
Cotulla Reservoir

- Flow Criteria Scenarios
 - None
 - Full BBEST
 - Modified BBEST
 - No Overbank Flow Criteria
 - No Overbank with 50% Rule and Avg. Base Flows
 - No Overbank with Dry Base Flows

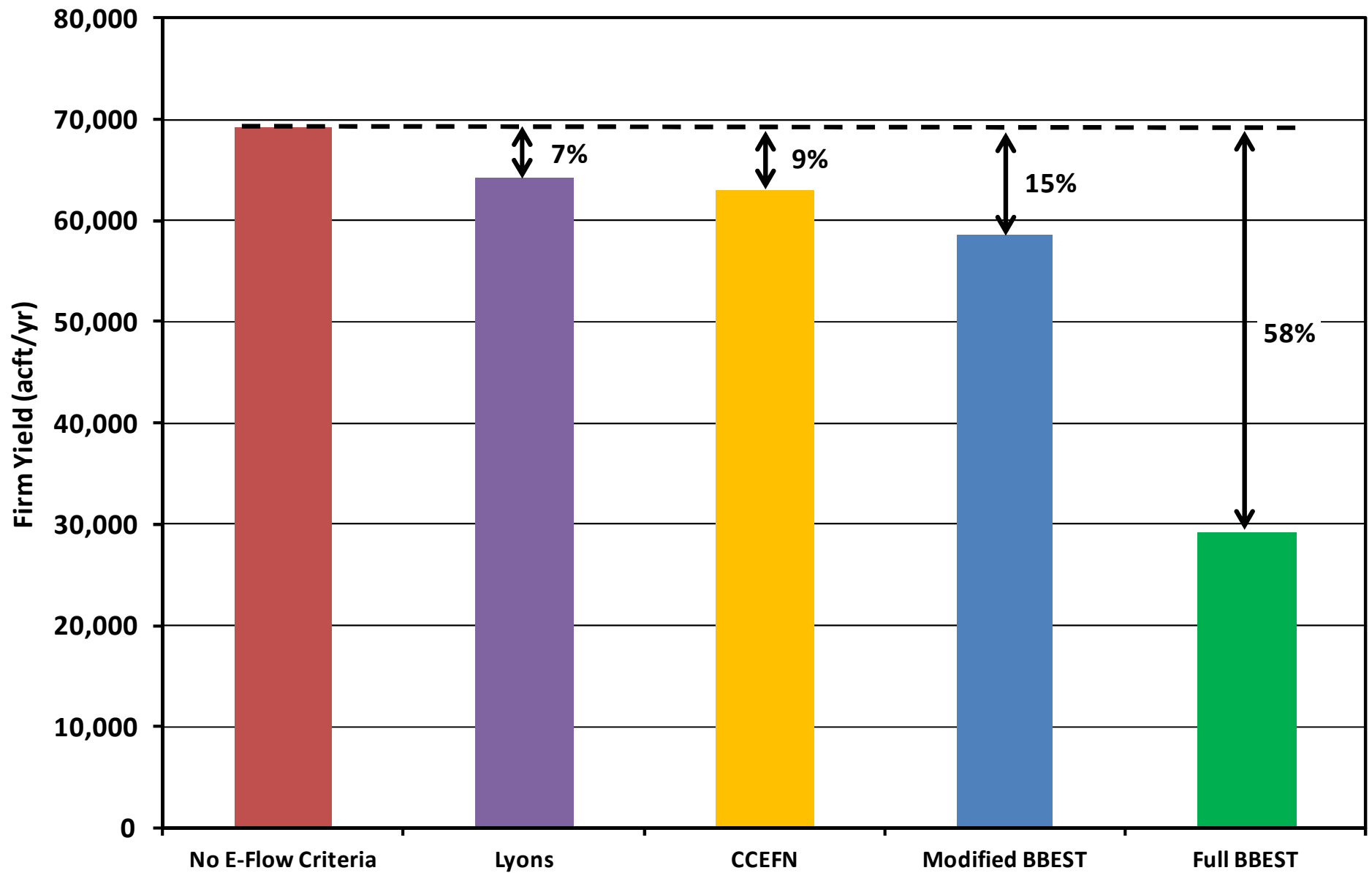
Cotulla Reservoir - Firm Yield



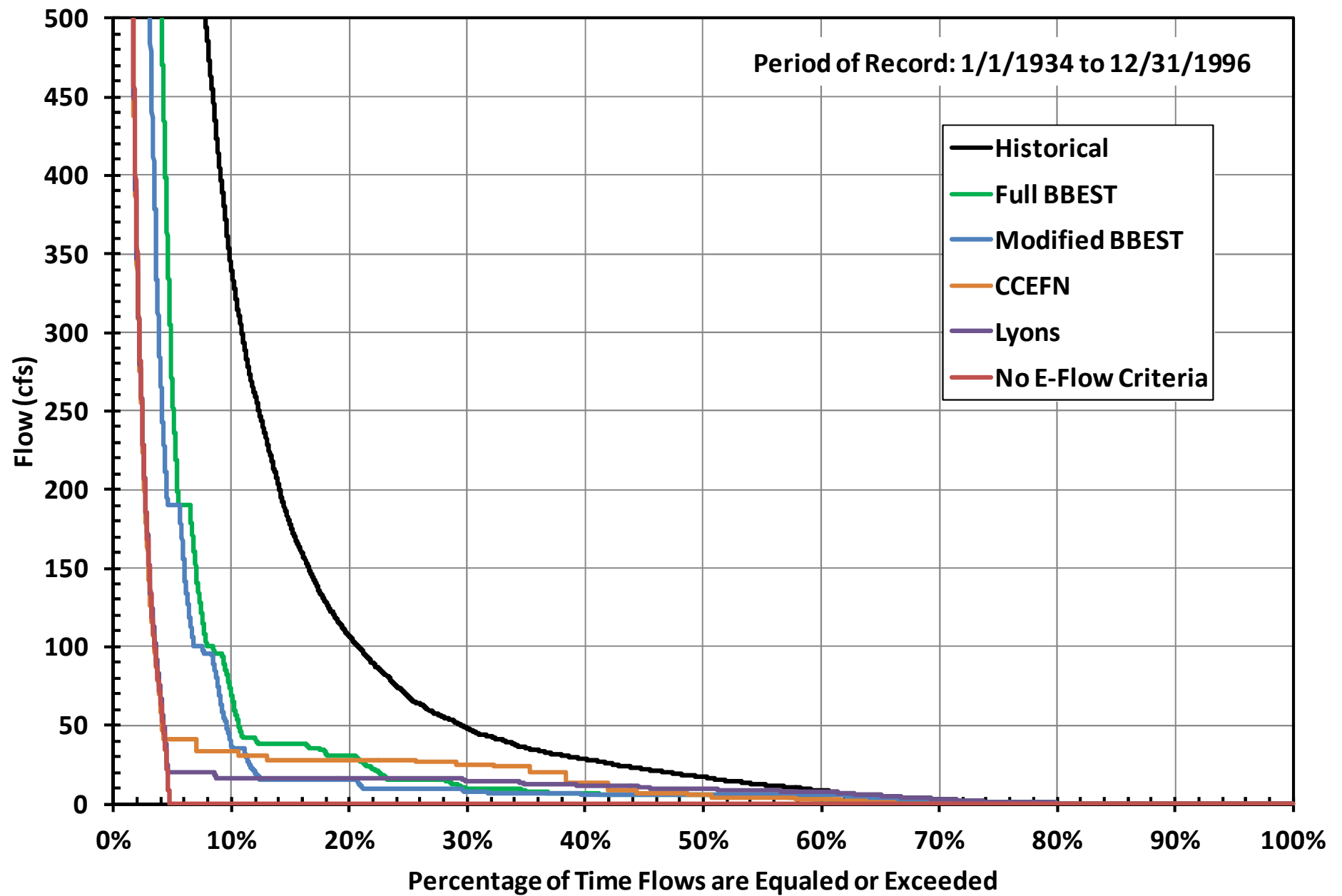
Cotulla Reservoir - Annual Flow Frequency Curve



Cotulla Reservoir - Firm Yield



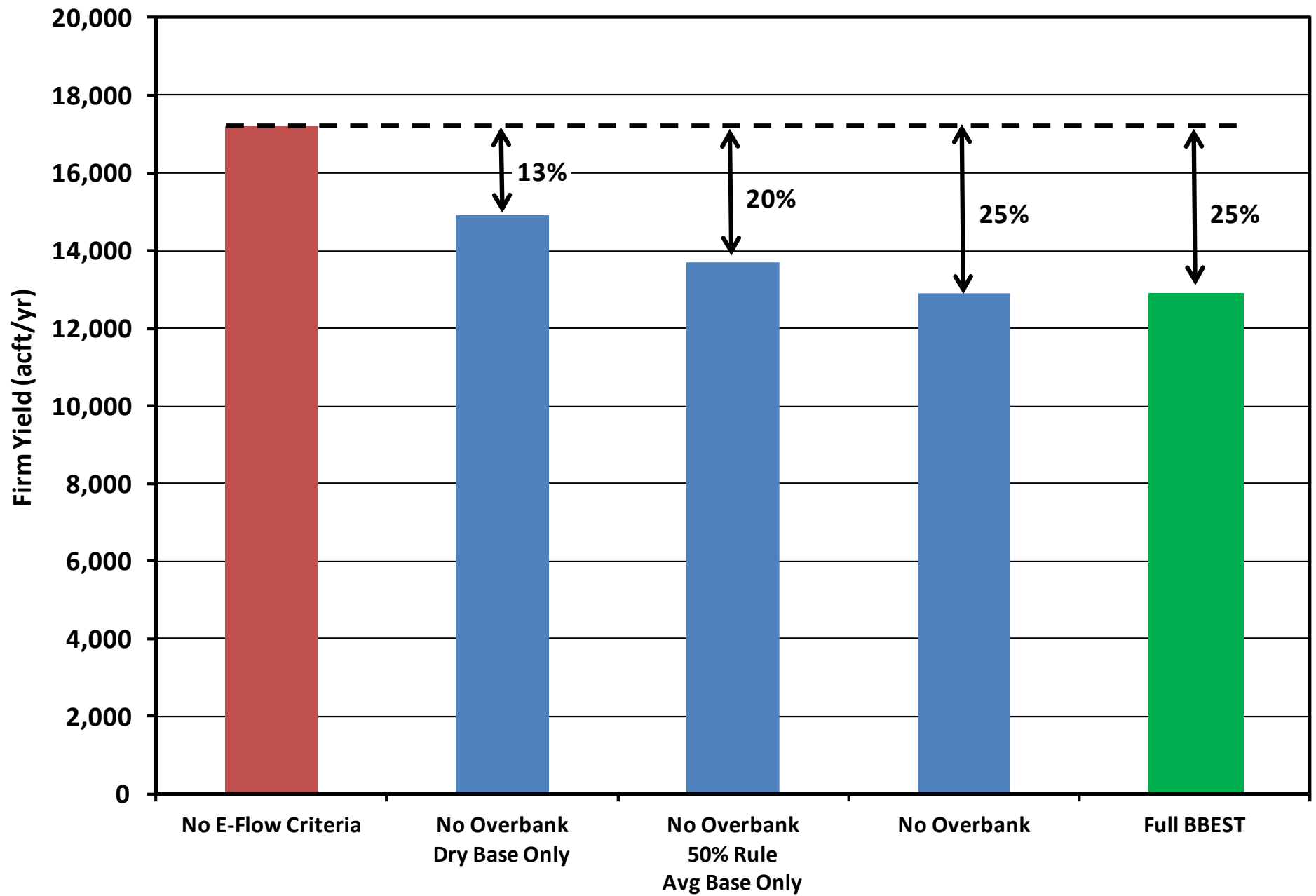
Cotulla Reservoir - Annual Flow Frequency Curve



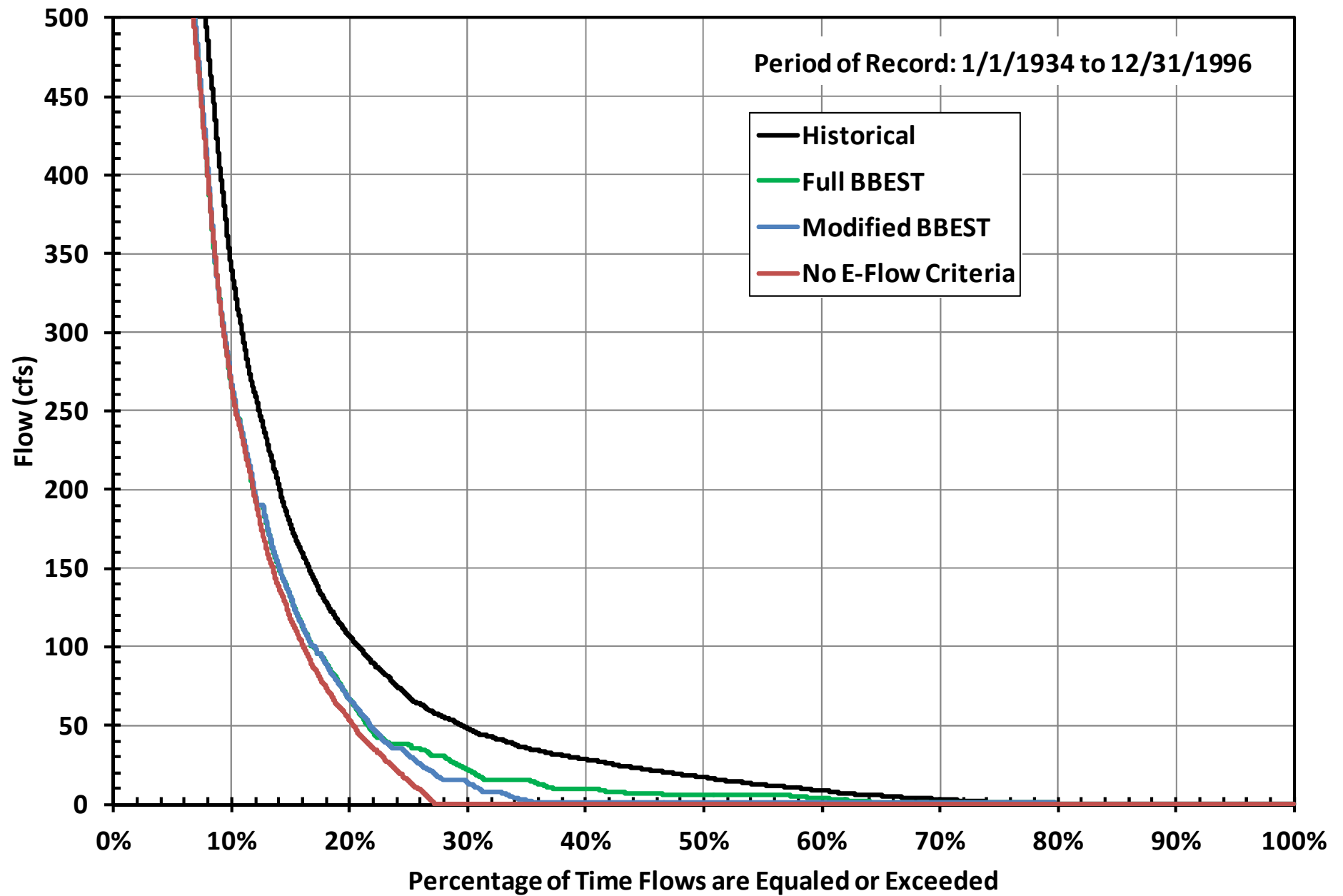
Cotulla ROTR OCR

- Flow Criteria Scenarios
 - None
 - Full BBEST
 - Modified BBEST
 - No Overbank Flow Criteria
 - Pulse Exemption Did Not Qualify
 - No Overbank with 50% Rule and Avg. Base Flows
 - No Overbank with Dry Base Flows

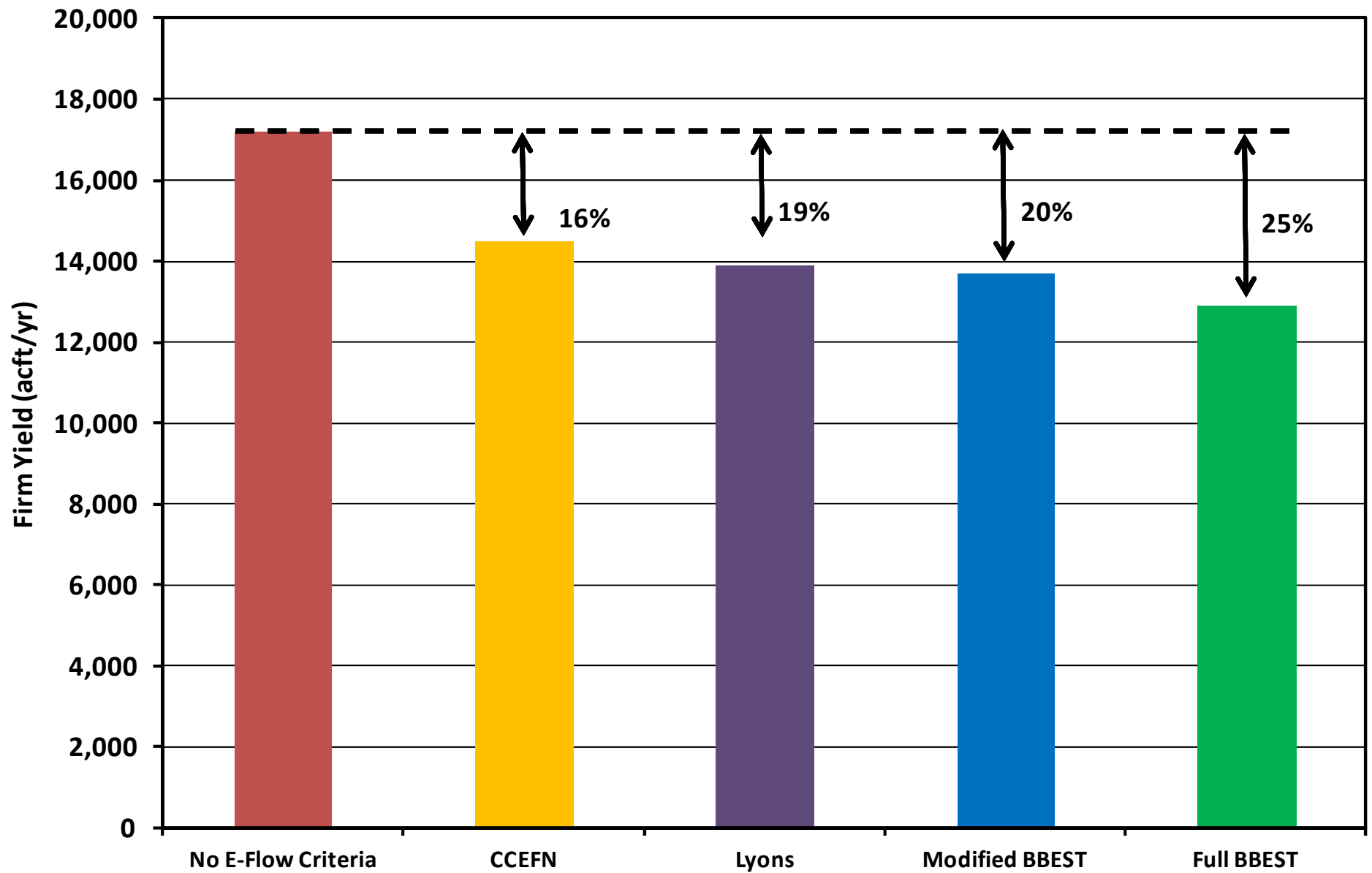
Cotulla Off-Channel Reservoir - Firm Yield



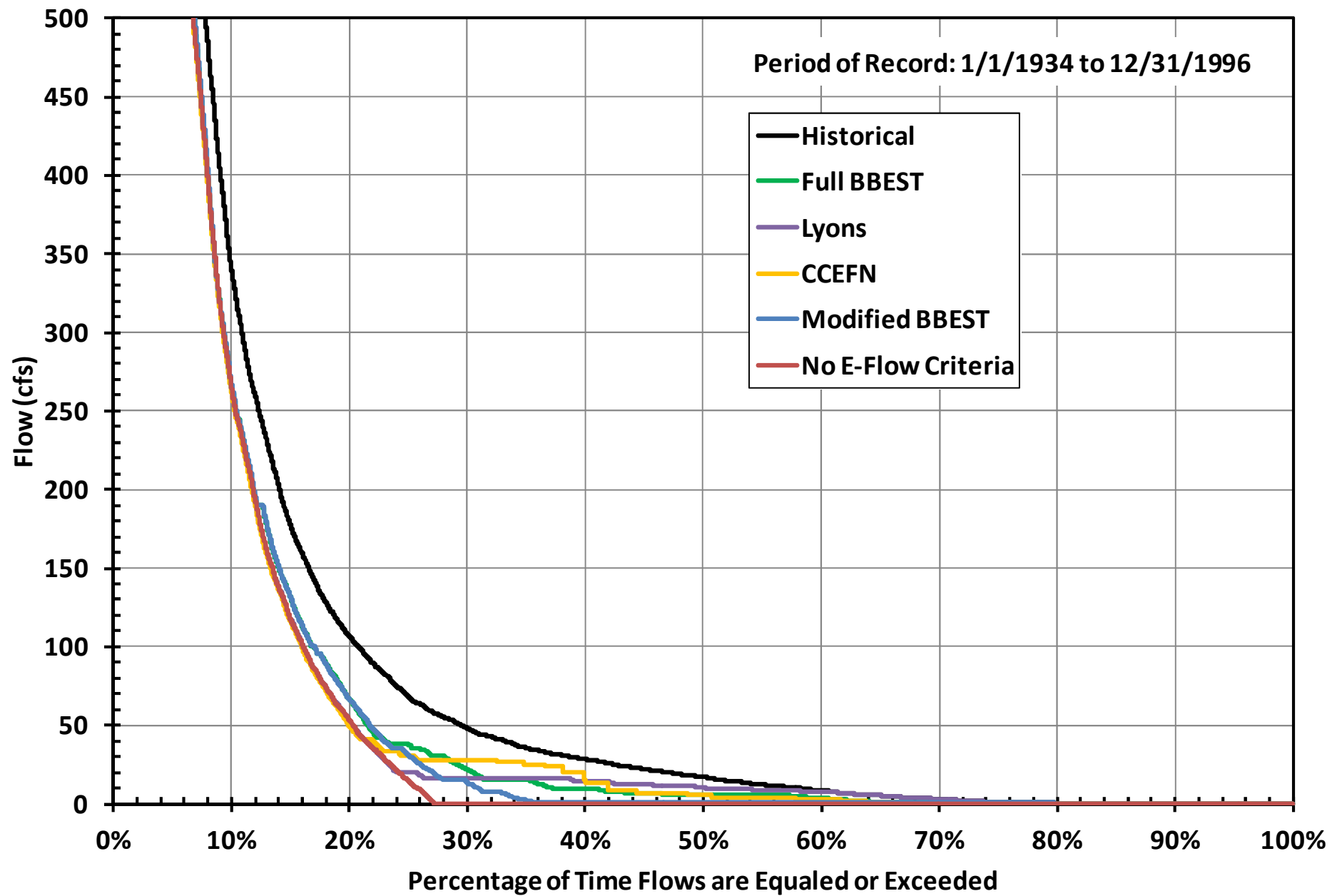
Cotulla Off-Channel Reservoir - Annual Flow Frequency Curve



Cotulla Off-Channel Reservoir - Firm Yield



Cotulla Off-Channel Reservoir - Annual Flow Frequency Curve



Path Forward

- Proposal for BBASC Instream Environmental Flow Standard Recommendation
 - Modified BBEST
 - Overbank Exemption
 - Pulse Exemption Rule
 - Average Base Flow with 50% Rule
 - BBEST
 - Alternative BBEST modification
- Continue Technical Analysis
 - Coordinate with BBEST to evaluate ecological effects of the Instream Recommendations

Corpus Christi Water Supply Model

- Period of Record 70 years (1934 – 2003)
- Monthly Model
- Change Demand on System
- Change B&E Operations
- Results
 - Bay Inflow
 - Reservoir Storage
 - System Yield

Order Compared to BBEST

2001 TCEQ Agreed Order

Sys Stor. %	Jan (acft)	Feb (acft)	Mar (acft)	Apr (acft)	May (acft)	Jun (acft)	Jul (acft)	Aug (acft)	Sep (acft)	Oct (acft)	Nov (acft)	Dec (acft)	Ann. (acft)
>70	2,500	2,500	3,500	3,500	25,500	25,500	6,500	6,500	28,500	20,000	9,000	4,500	138,000
70-40	2,500	2,500	3,500	3,500	23,500	23,000	4,500	5,000	11,500	9,000	4,000	4,500	97,000
40-30	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	14,400
>30	0	0	0	0	0	0	0	0	0	0	0	0	0

2011 BBEST Recommendation

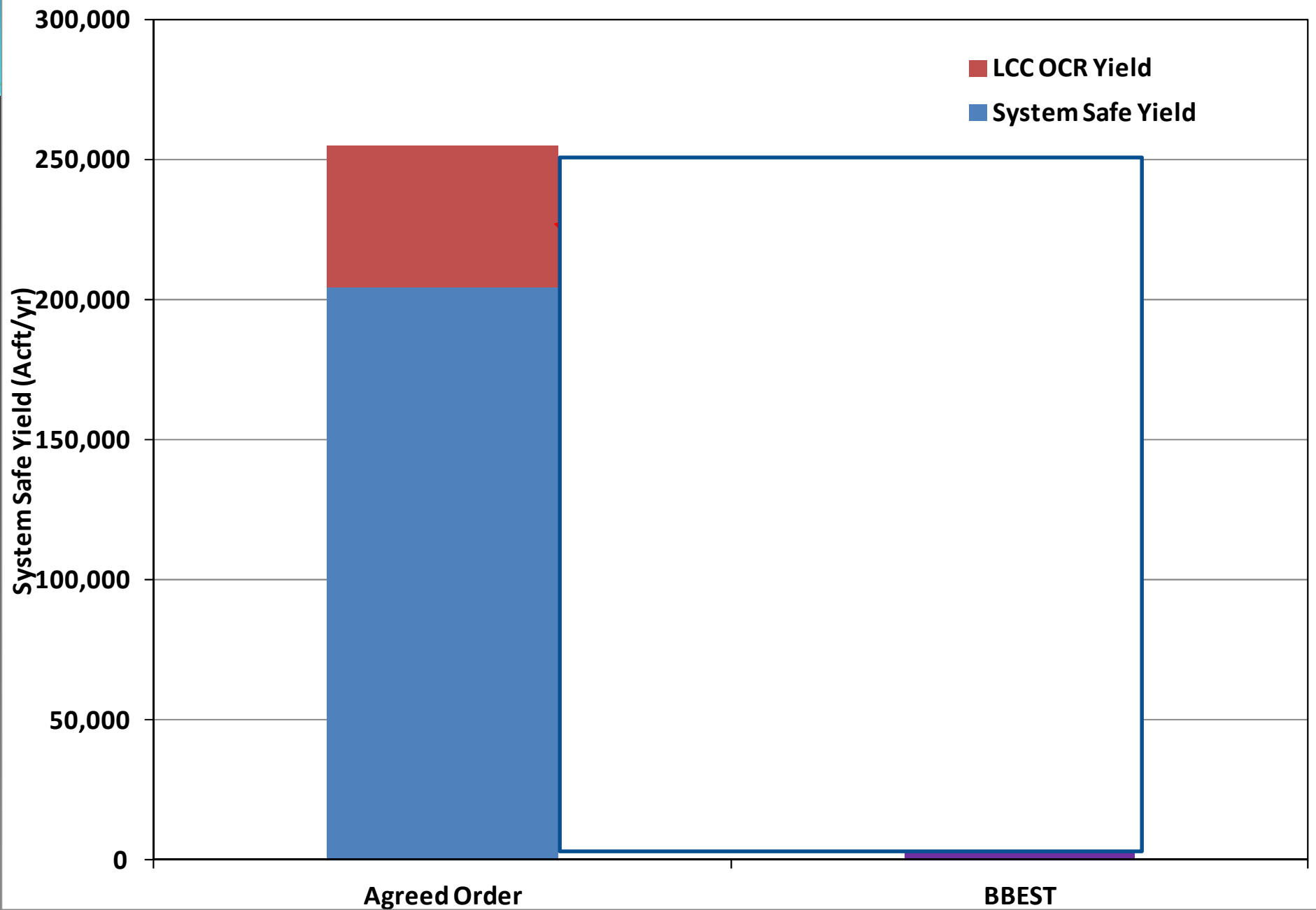
Condition (Target Salinity)	Nueces Bay Freshwater Inflow Regime (Attainment)			Recommendations	
	One overbanking event per year of 39,000 acft; maximum discharge of 3,600 cfs			Annual Total (acft)	Attainment
High (10)	125,000 acft (20%)	250,000 acft (25%)	375,000 (20%)	750,000	25%
Base (18)	22,000 acft (60%)	88,000 acft (60%)	56,000 (75%)	166,000	80%
Subsistence (34)	5,000 acft (95%)	10,000 acft (95%)	15,000 acft (95%)	30,000	95%
	Winter = Nov - Feb	Spring = Mar - Jun	Summer/Fall = Jul - Oct		



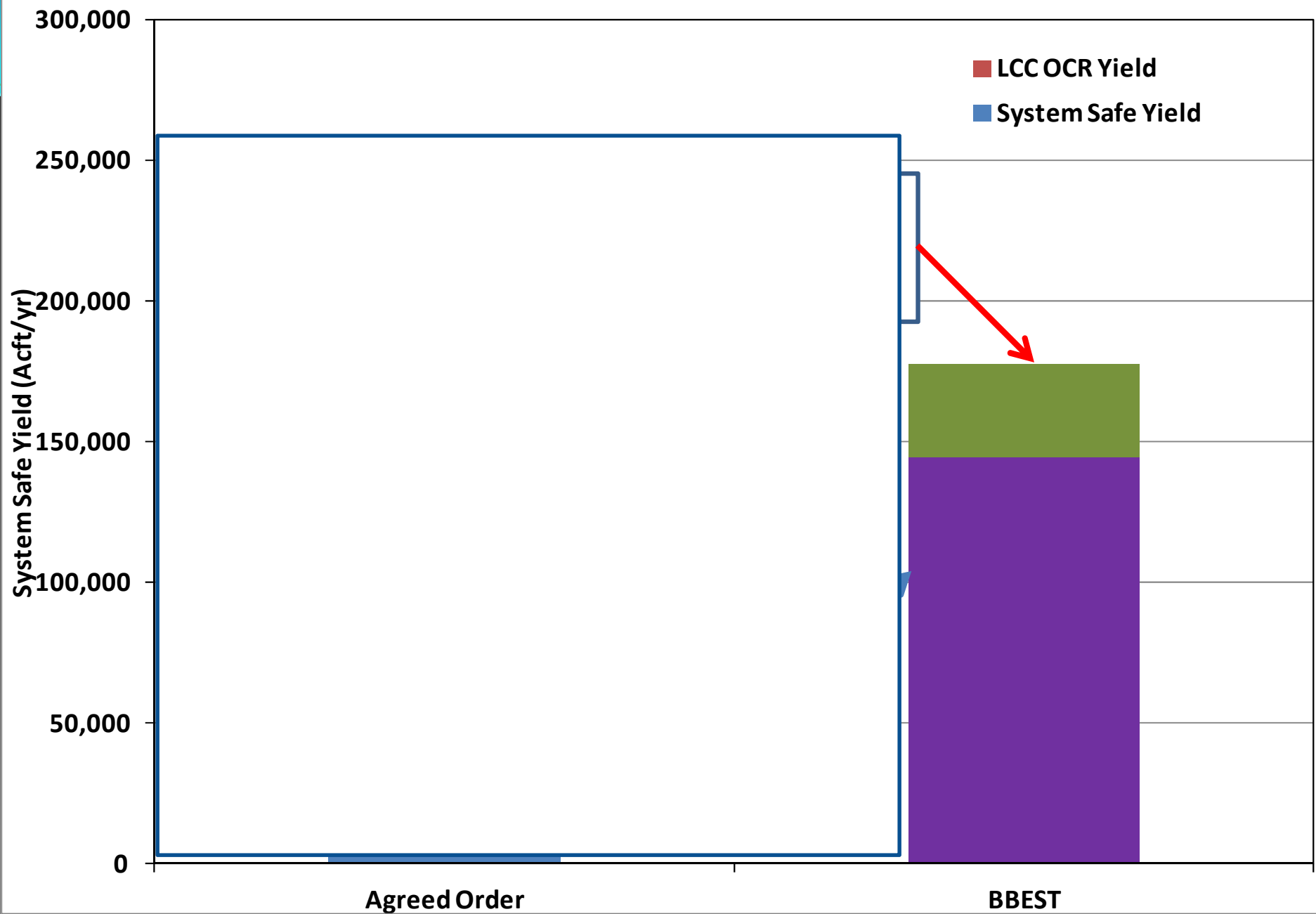
Planned Water Supply Projects

- Lake Corpus Christi – Off Channel Reservoir (LCC – OCR)
- 280,000 acft capacity
- Divert flood flows and top foot of LCC
- Refill LCC trigger at 80 ft-msl.
- Maximum 1,250 cfs diversion rate
- Modeled with
 - Existing TCEQ Agreed Order
 - BBEST Recommendation (Operational)

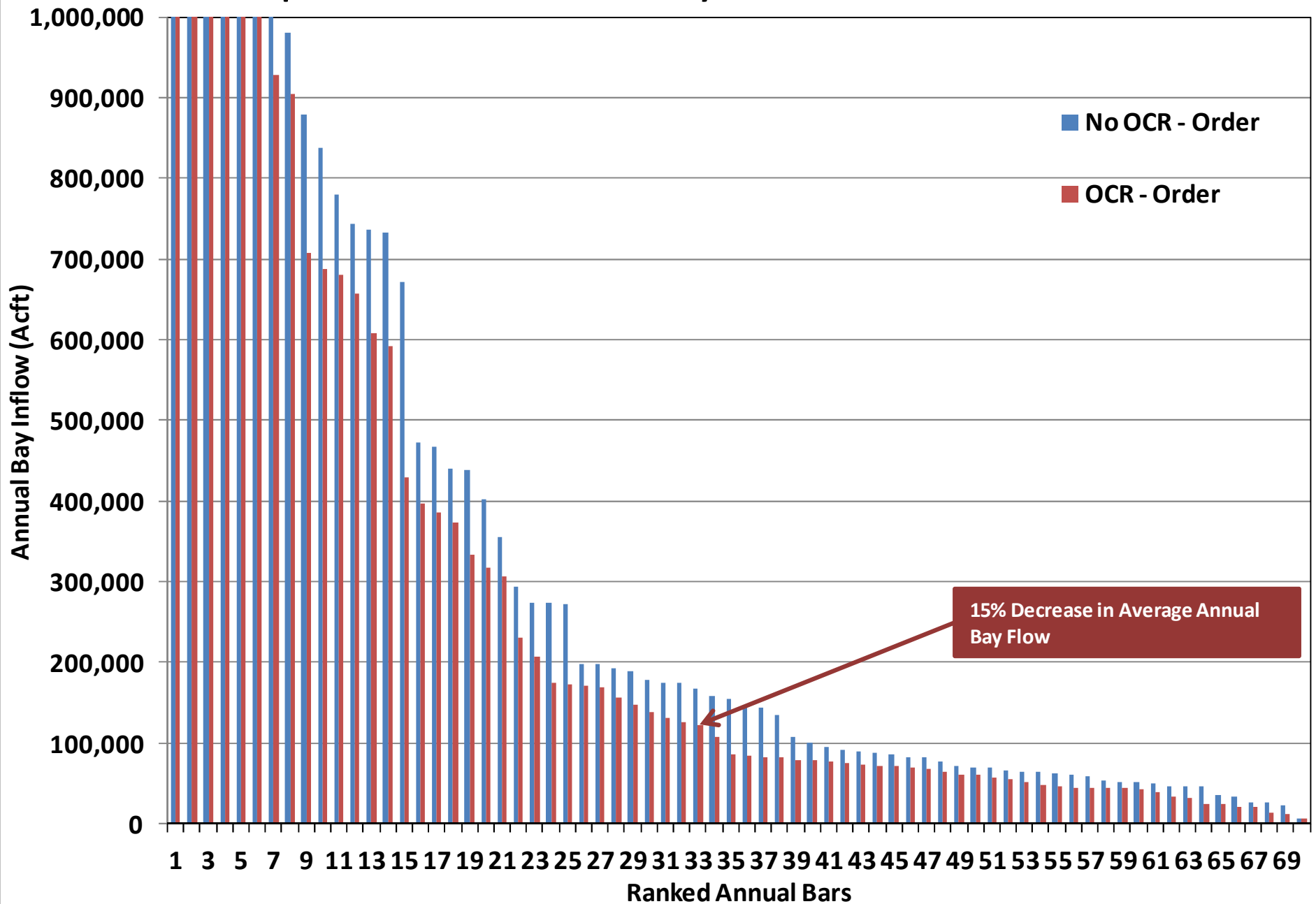
System Safe Yield Comparison with OCR and B&E Recommendations



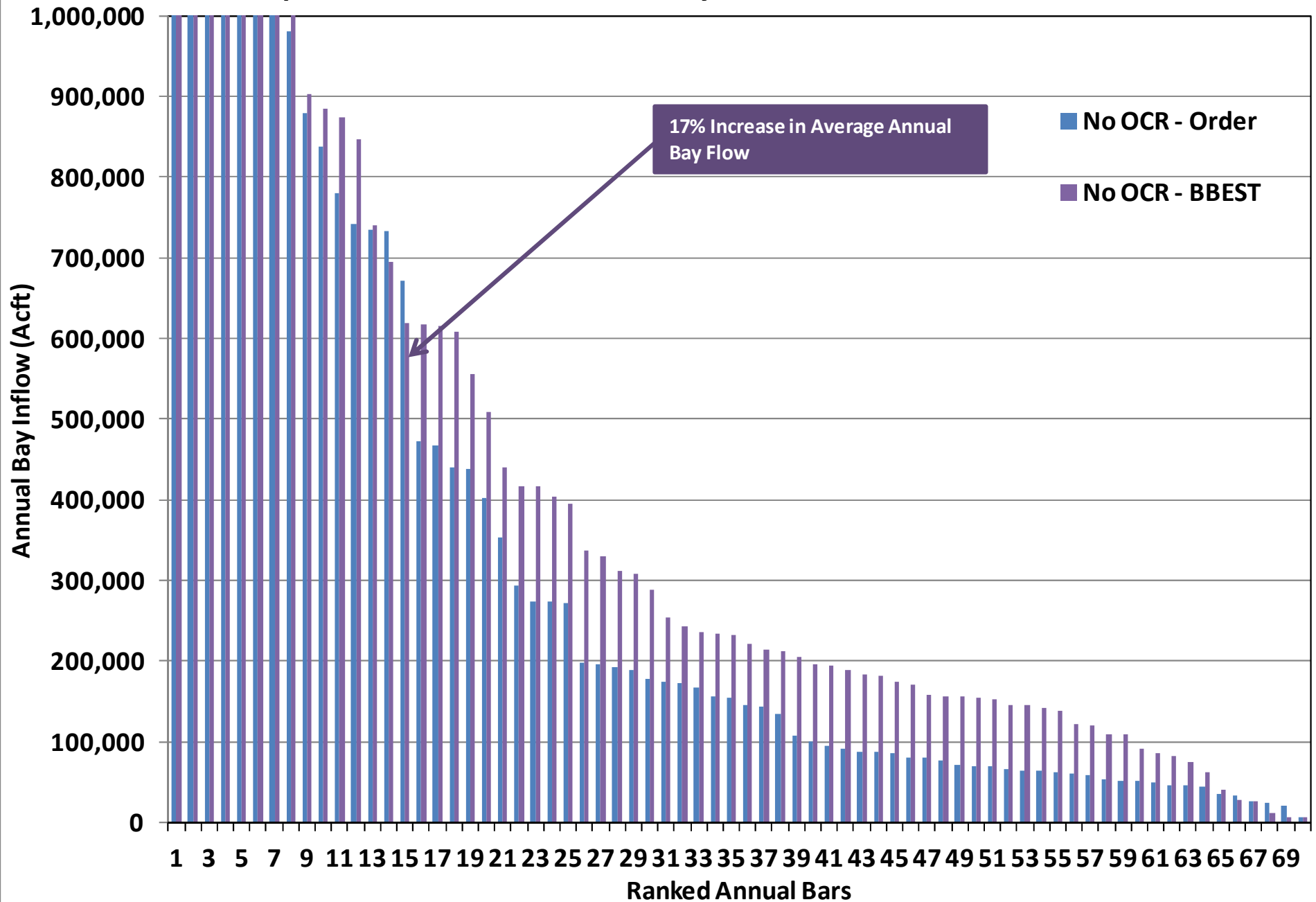
System Safe Yield Comparison with OCR and B&E Recommendations



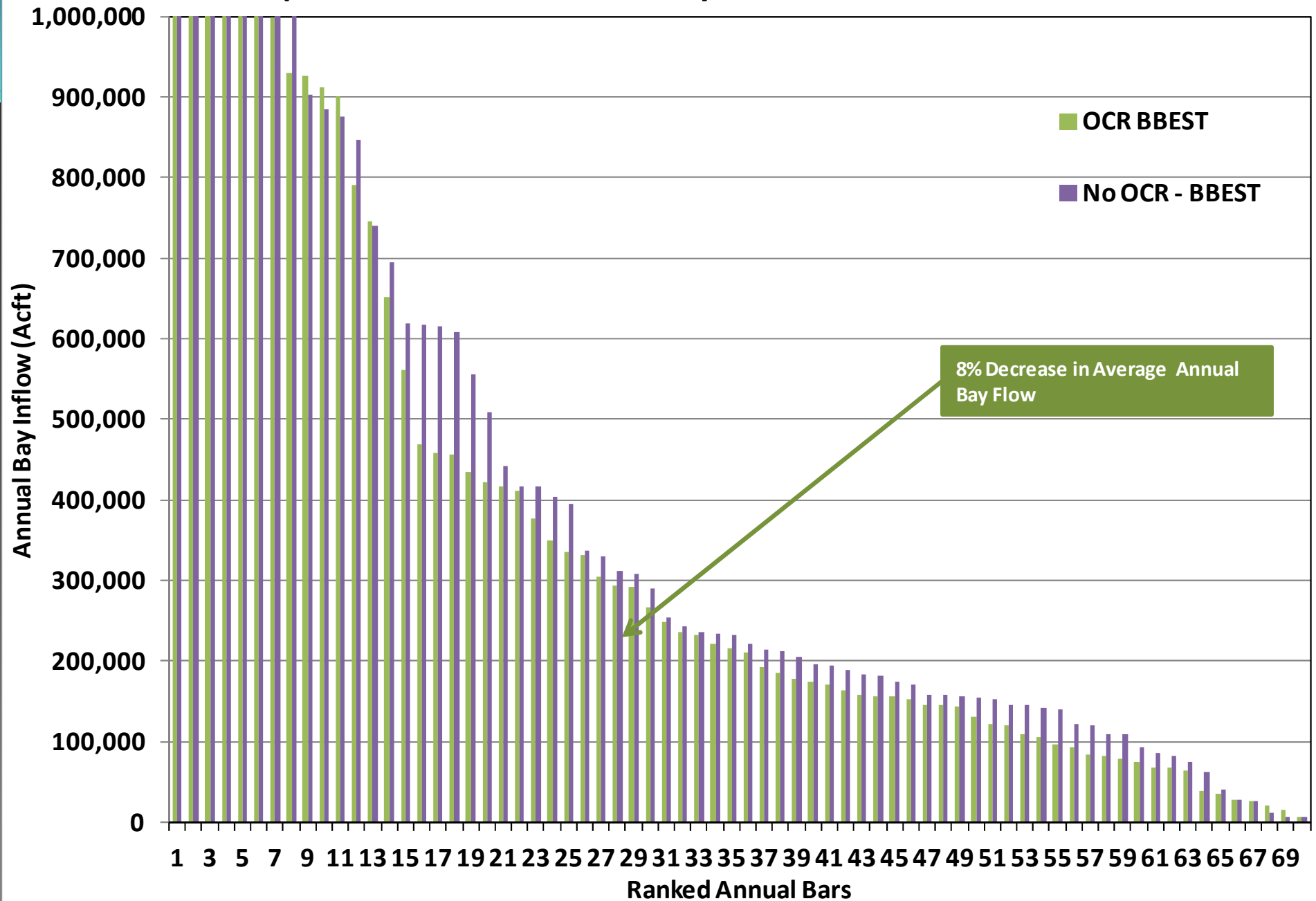
Comparison of Ranked Annual Bay Inflow - LCC-OCR Scenarios



Comparison of Ranked Annual Bay Inflow - LCC-OCR Scenarios



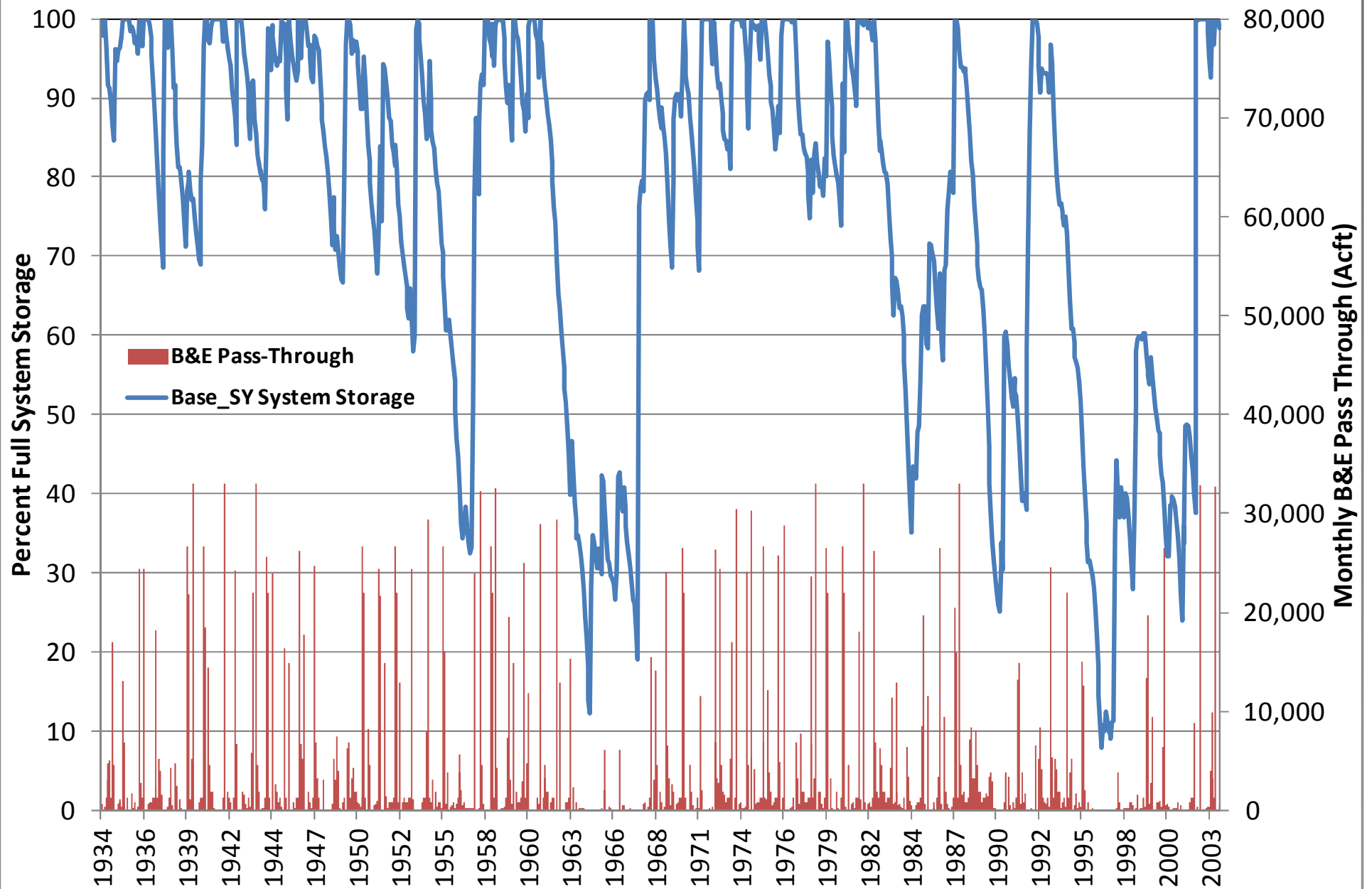
Comparison of Ranked Annual Bay Inflow - LCC-OCR Scenarios



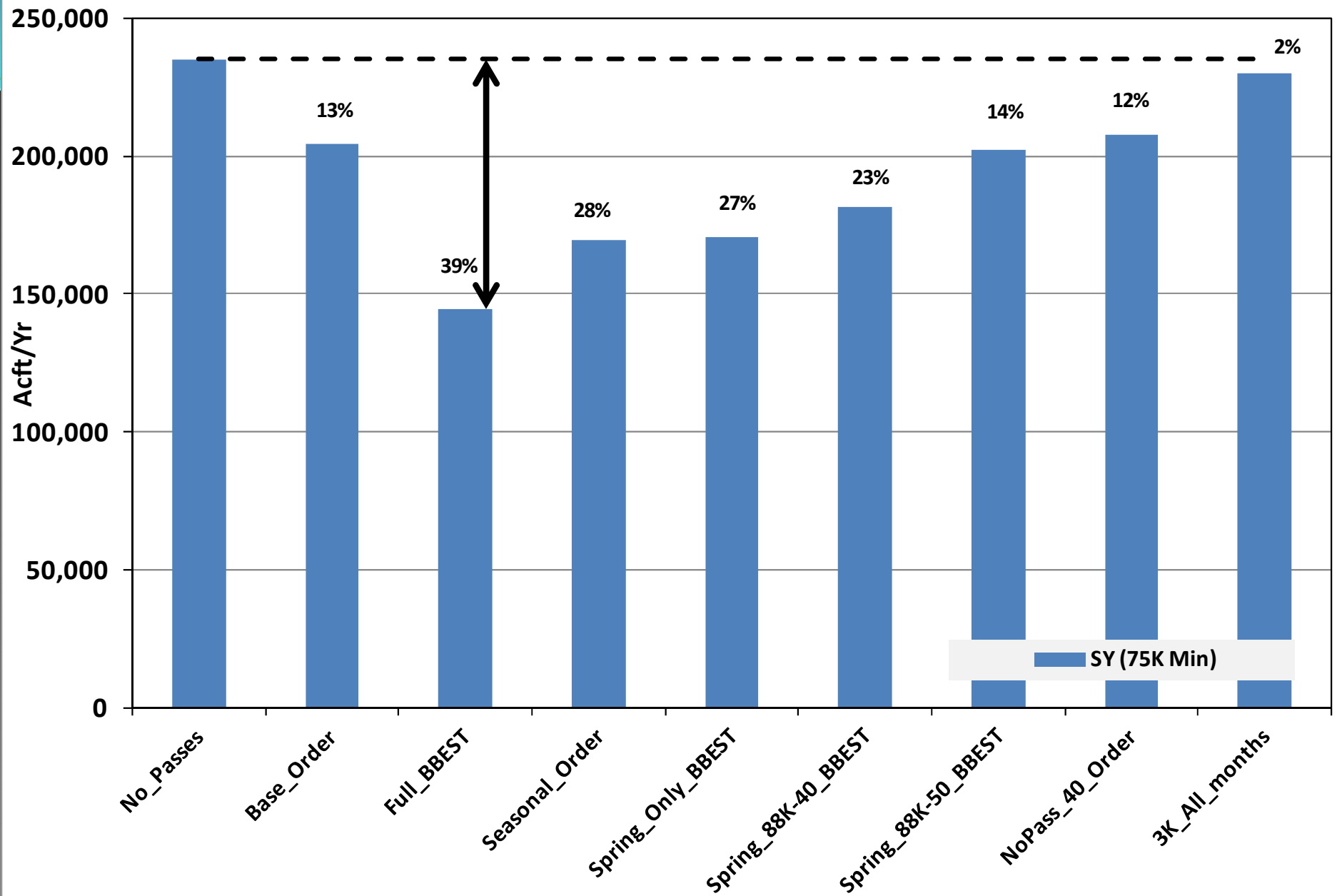
CCWSM Scenarios and B&E Analysis

- Modeled Safe Yield Scenarios (75K Min Stor)
 - No Pass-Throughs
 - Base – Safe Yield – Order
 - Full – BBEST
 - Seasonal – Order
 - Spring Only Targets - BBEST
 - Full BBEST
 - 88,000 – 40%
 - 88,000 – 50%
 - No Pass-Throughs – 40%
 - 3,000 All Months

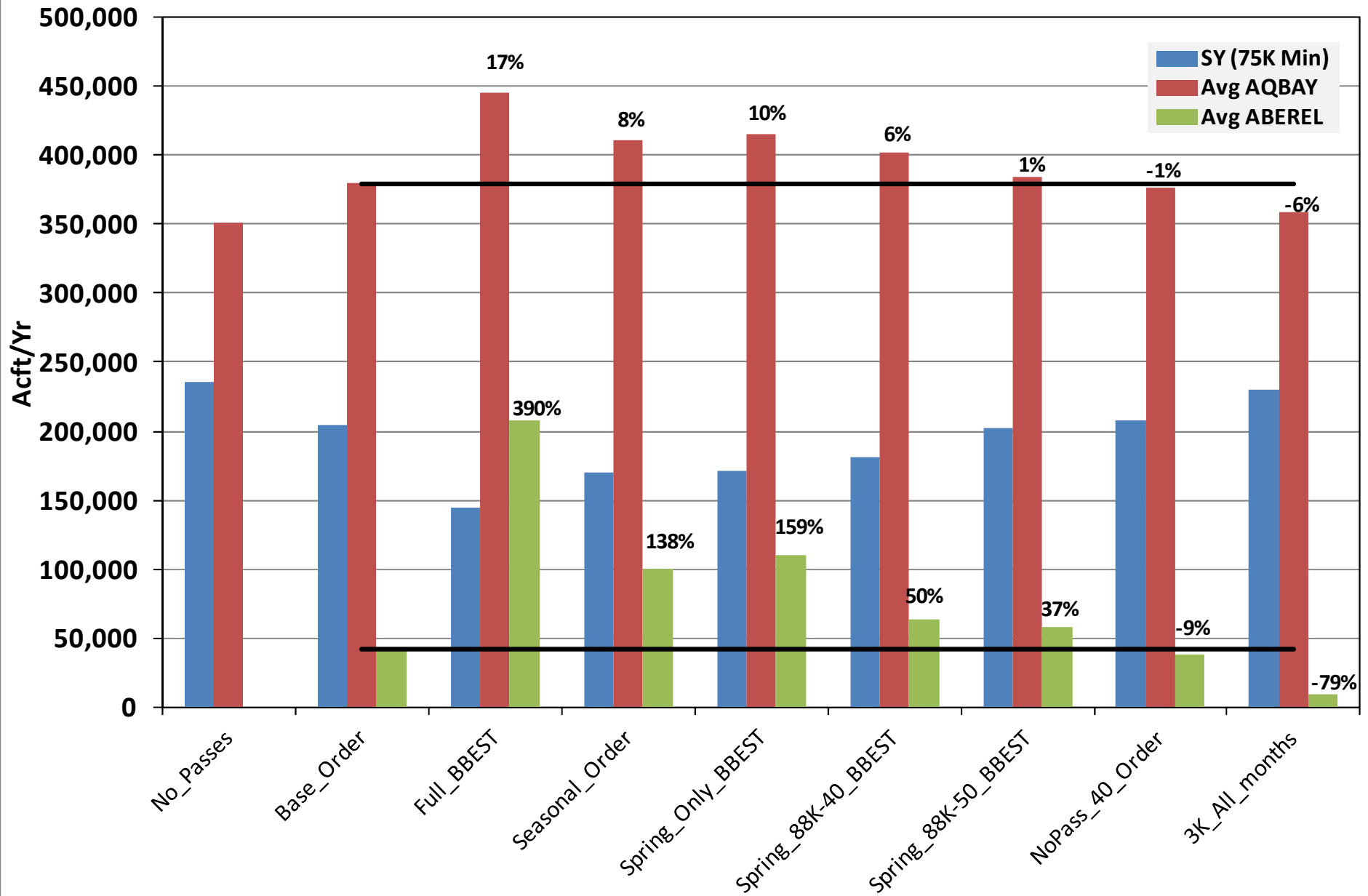
CCR/LCC System Storage and Monthly Pass-Throughs



CCR/LCC/LT System Safe Yield (acft/yr)



CCR/LCC/LT System Safe Yield - Average Annual Bay Inflow - Average Annual B&E Release



Path Forward / Questions?

- Continue Technical Analysis
 - Refine B&E Analysis
 - Provide Flows for TxBLEND Analysis
- Report Compilation





Sabinal Yield Plot with modified BBEST



Sabinal Yield Plot with Streamflows

Agreed Order Compared to BBEST Recommendation

2001 TCEQ Agreed Order

- Operational
- Monthly
- 4 Defined Storage Zones
- Based on System Storage
- Below 30% - No Passes
- Salinity & “Spill Banking” Relief

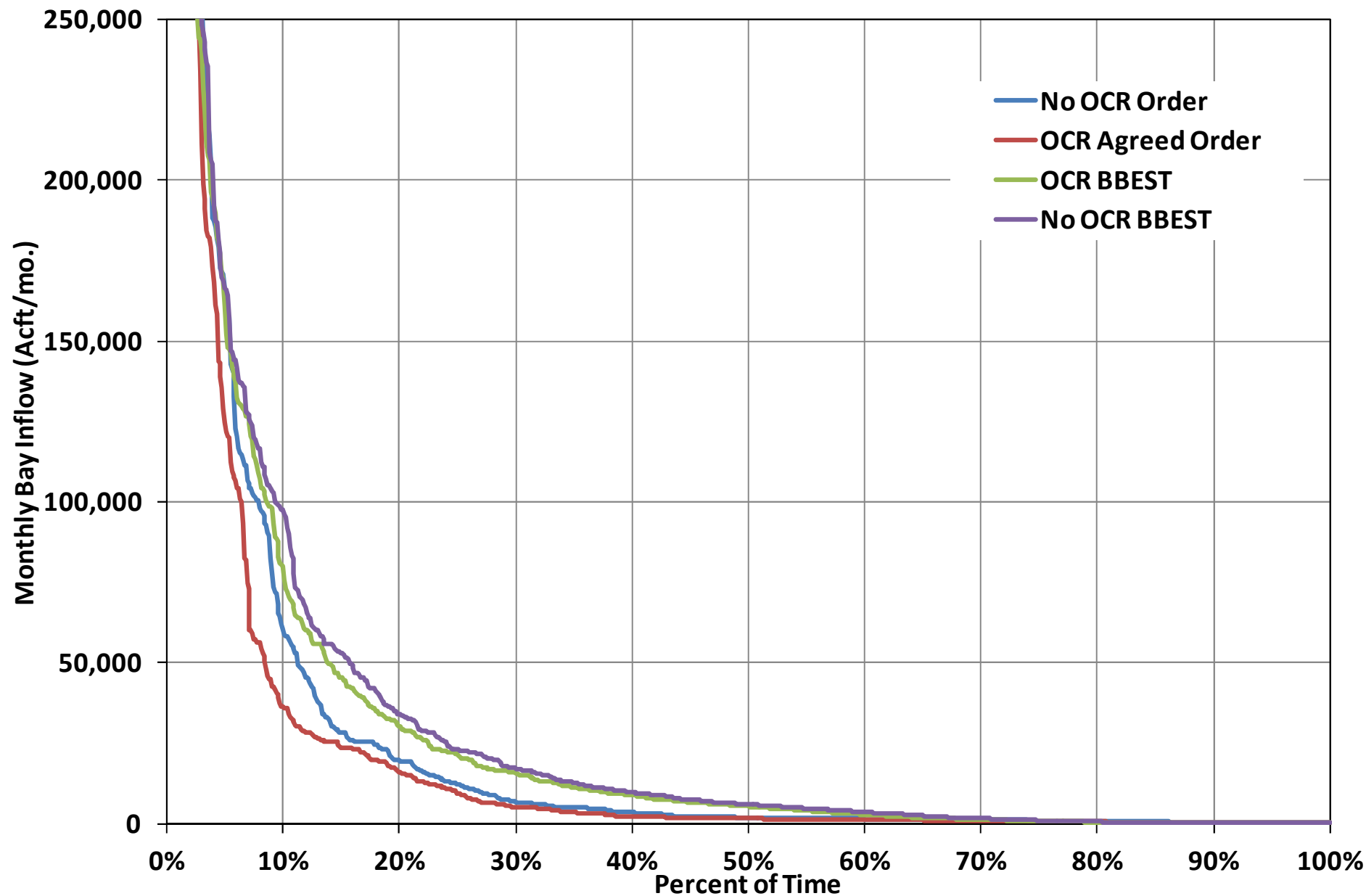


BBEST Recommendation

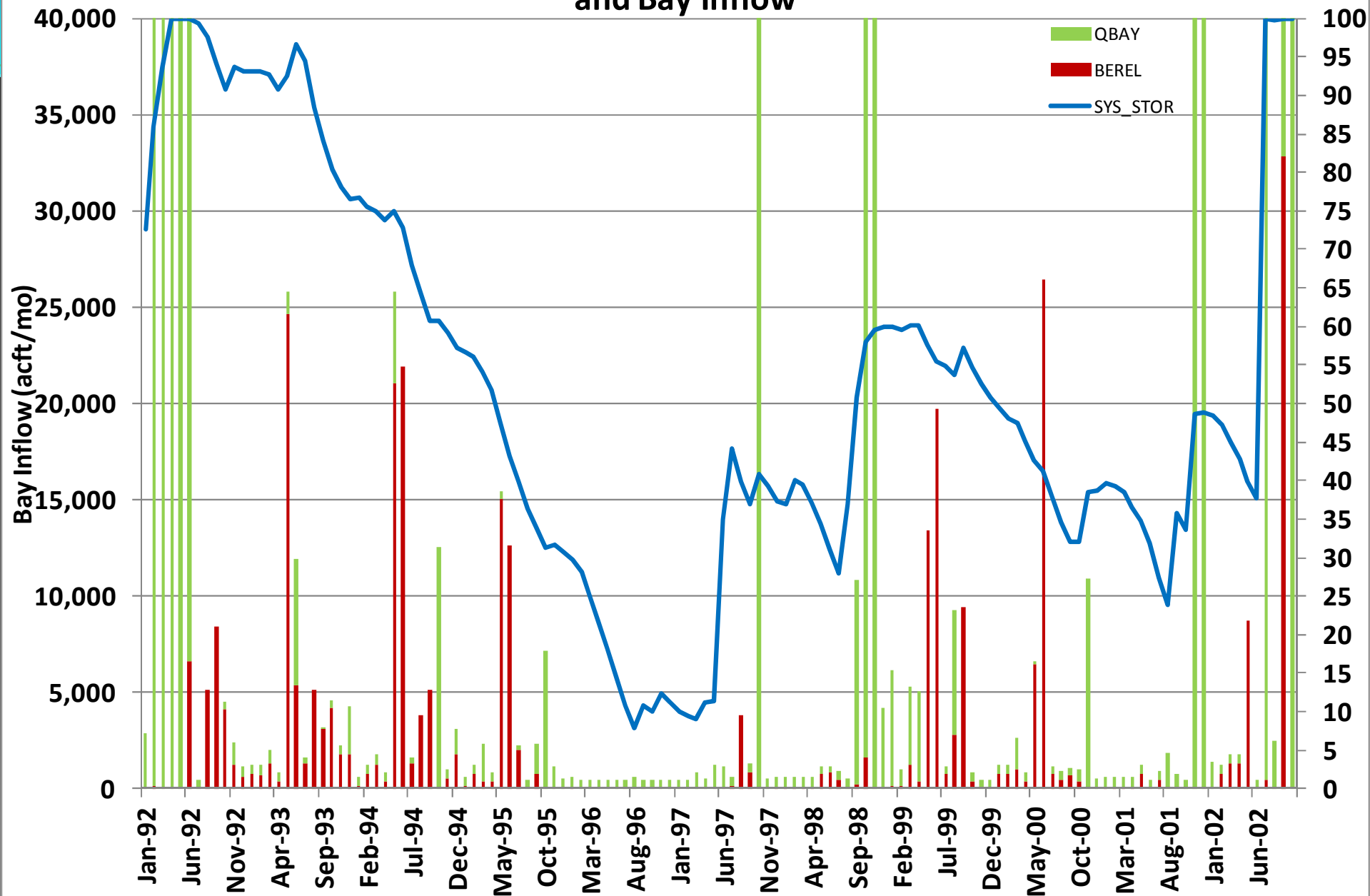
- Long-Term Simulation
- Seasonal
- 3 Hydrologic Conditions
- No Relation to System Storage
- Passes in all Zones
- No Relief Provisions



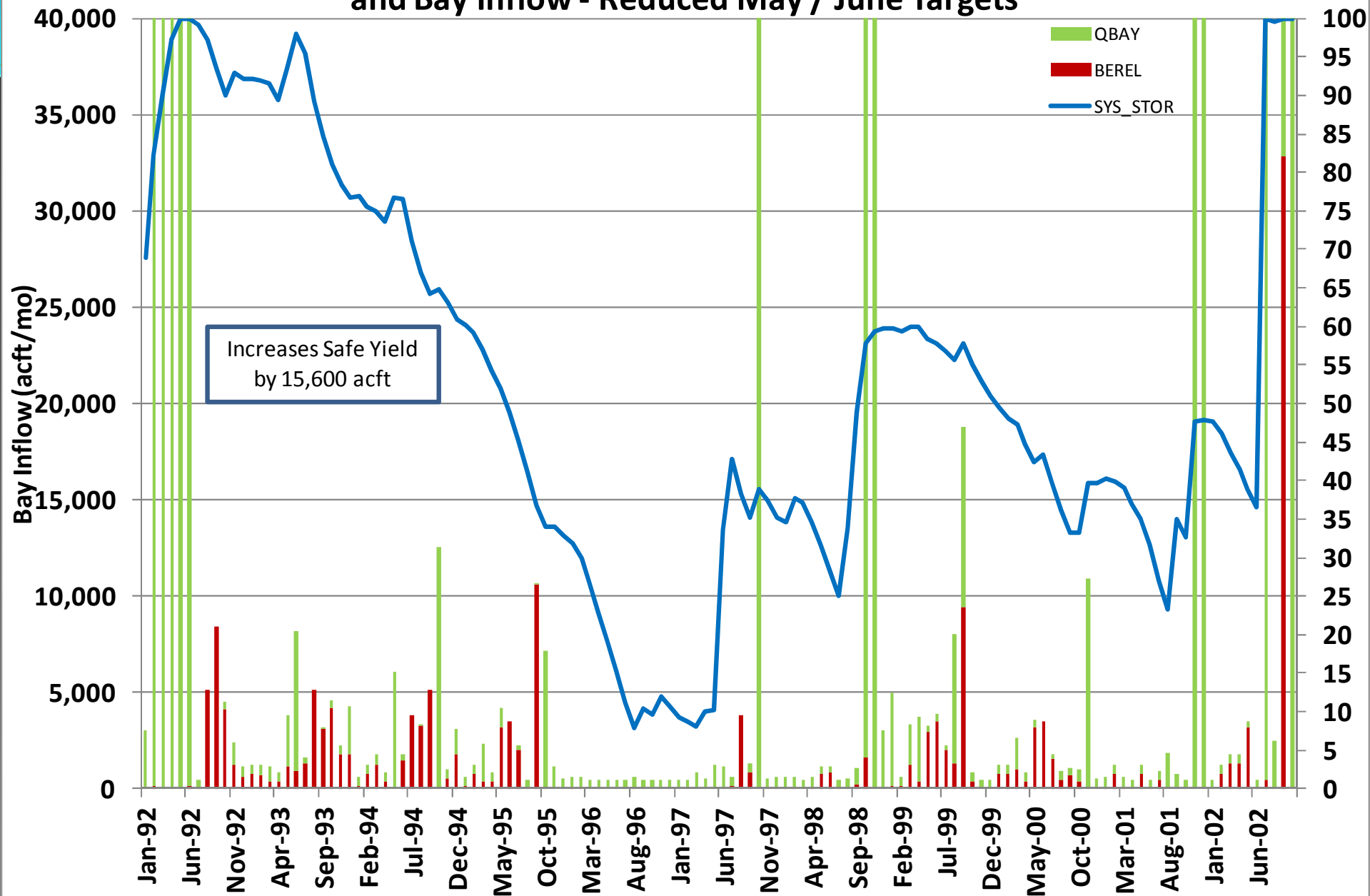
Frequency Plot of Monthly Bay Inflow - LCC-OCR Scenarios



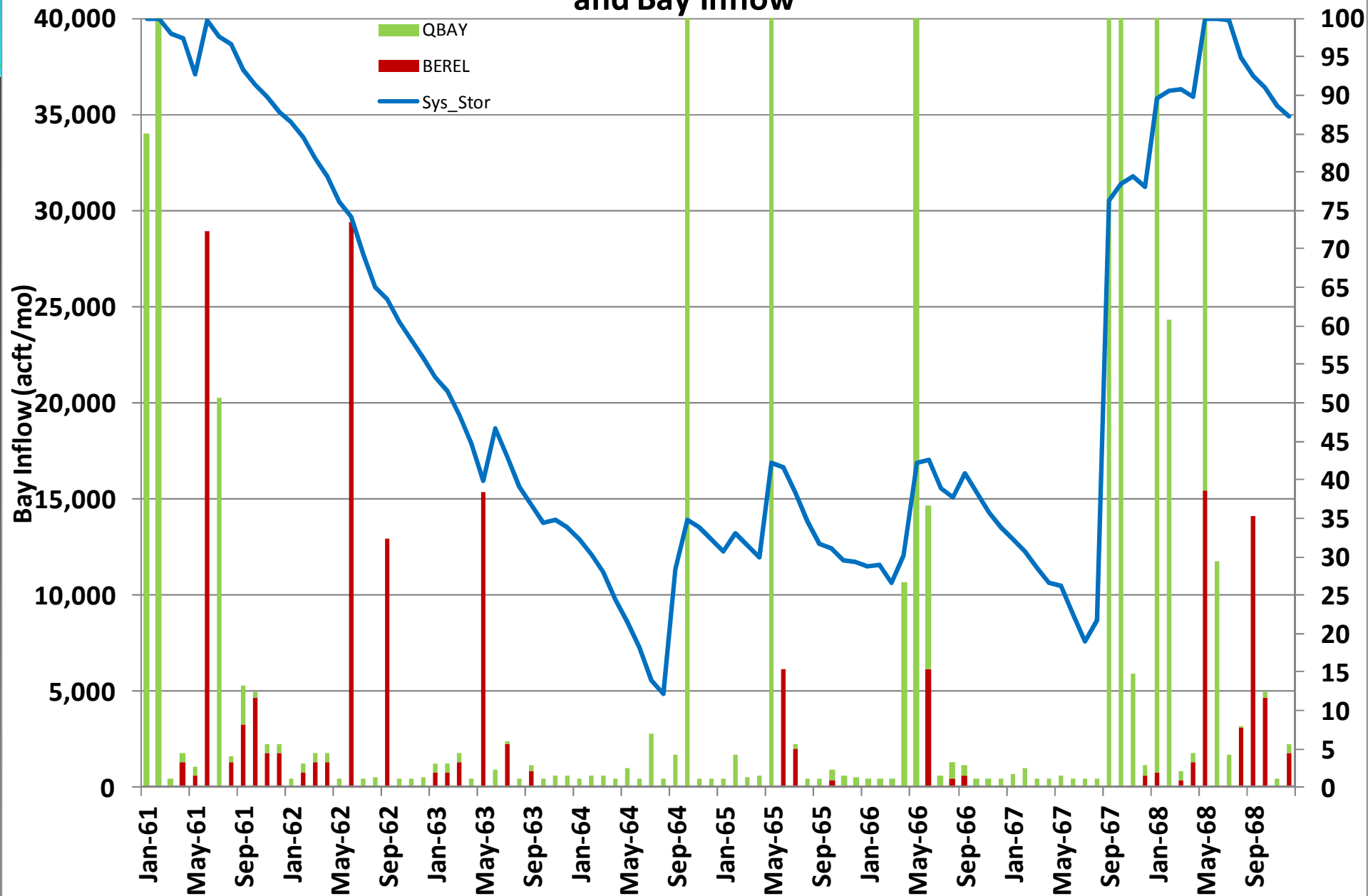
1992 - 2002 Drought Data comparing System Storage, Pass-Throughs and Bay Inflow



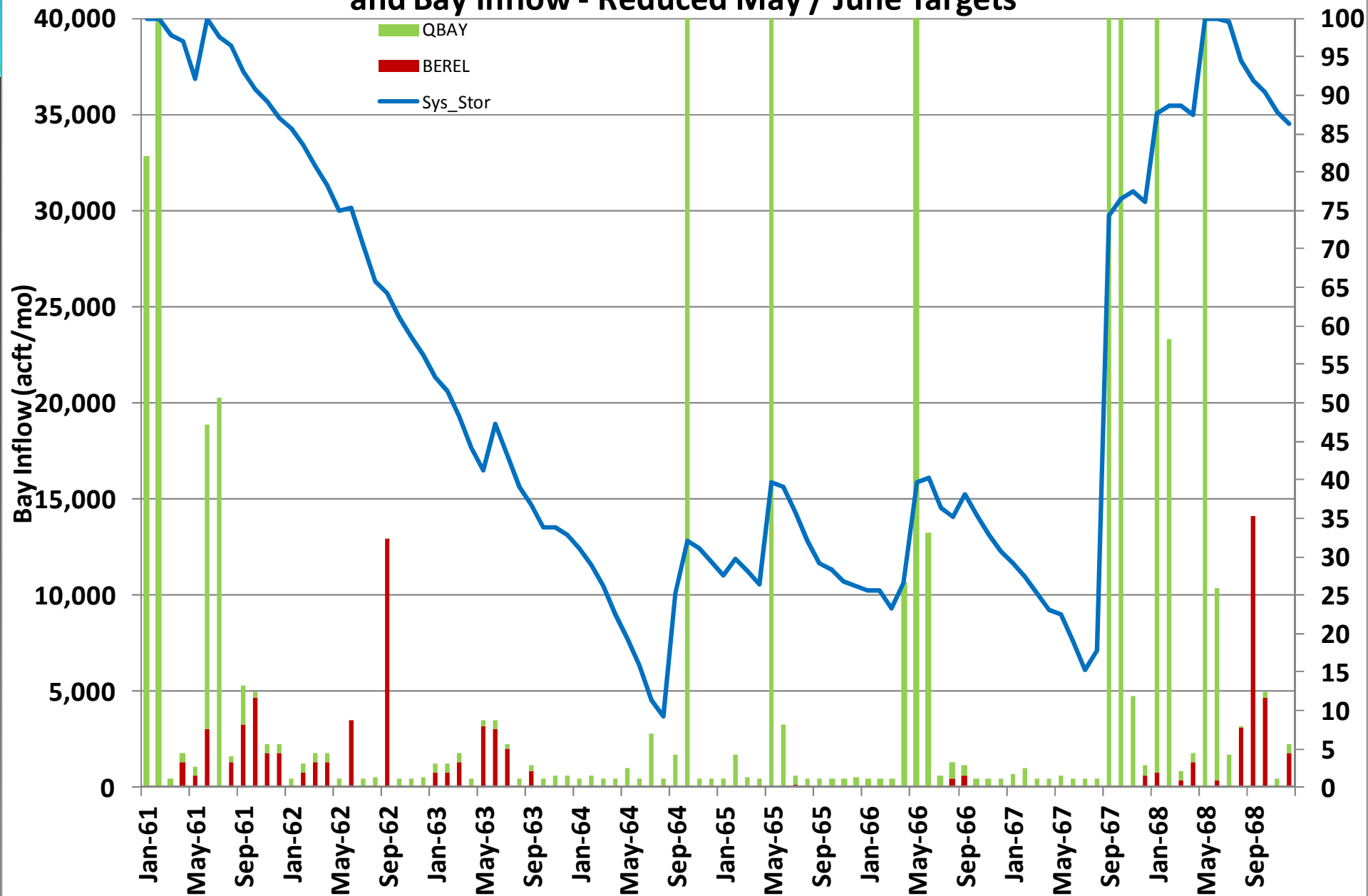
1992 - 2002 Drought Data comparing System Storage, Pass-Throughs and Bay Inflow - Reduced May / June Targets



1961 - 1968 Drought Data comparing System Storage, Pass-Throughs and Bay Inflow



1961 - 1968 Drought Data comparing System Storage, Pass-Throughs and Bay Inflow - Reduced May / June Targets



Scenario Results

- Yield vs. Avg. Annual Bay Inflow

Run #	Run Description	SY (75K Min)	Avg AQBAY
1	Base_SY	204,449	379,284
2	No_PT	235,001	350,800
3	Seasonal_order	169,691	410,454
4	Spring_target	170,889	415,491
5	Summer_Tar	180,960	405,900
6	Winter_Tar	213,264	372,547
7	3K_All_months	230,089	358,019
8	Reduced may June	220,110	364,423

Monthly Bay Inflow - Frequency

